PLURALISM IN EXTENSION EDUCATION METHODOLOGIES FOR TECHNOLOGY APPLICATIONS
A Case of Potato Technology in India

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ABSTRACT

Existence of several service providers in the Extension Systems has necessitated the convergence of their activities to make extension methods more robust and effective. In this paper, attempts are made to substantiate the models of the respective service providers with their relevant research support. Experiences emanated from these models approaches have revealed that no single recipe is valid across various agro-ecological reasons. Combination of approaches seems to be appropriate provided the felt needs and priorities of the farmers are accurately addressed. A point is, therefore, drawn that for a given commodity different possible options of technology applications be embedded in a prevailing agro-eco situations. Pluralism is thus needed more at micro levels of extension education methodologies rather than in institutional protocols of technology applications.

Keywords: Service Providers, Pluralism, Technology Applications, Convergence, Potato

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Pluralism in agricultural extension envisages the prevalence of multiple agencies, service providers, models, and institutional arrangements (public, private, community based, NGOs etc.) which are engaged in catering to the information, advisory and support service needs of farmers. The singularity of public extension system is over in the present day scenario. Extension has become a complex web of many actors in agricultural innovation systems Sajesh et al., (2018). Pluralism in agricultural extension is the irrefutable fact harnessing the synergy of various actors to optimize their contribution in the welfare of farming community. It has now become the area of interest. As the large numbers of partners are involved in the information advisory backstopping and support services to the farmers, integrating their activities is imminent.

Sulaiman *et al.* (2012) have observed that pluralism has brought additional manpower and resources for extension and advisory services (EAS) and has also brought new knowledge, skills, and expertise. It also brought additional challenges of ensuring quality, providing technical backstopping, and ensuring synergy between diverse EAS providers. Importance of the idea of convergence takes centre stage in this context. Convergence is not about complete collaboration among various agencies, but their involvement is required across the chain, from production to marketing (Sajesh and Suresh, 2016). It has also been argued in the above paragraph that convergence of extension models is also inevitable to make the extension methods more robust and effective. In other word, it is important to combine different approaches which have been found appropriate in varied situations for a commodity or the group of commodities or enterprise to see whether the above postulate of methodological pluralism is valid or otherwise. John Richardson (2007) has found that Convergence of newer technologies with Management & Technology Systems has made these Systems to reach a level of Capability whereby both Personnel Management Information and Program Accountability Information can be extracted from a Single Reporting Point. Against this background, this paper attempts to synthesize the various models of technology applications emerged across different agro-ecological regions of India with particular reference to potato.

Globally, 380 million tonnes of potato is produced in more than 100 countries and 50% of this is consumed fresh. The tuber is important for food security for millions of people across South America, Africa, Europe and Asia. India produced about 53 million tonnes of potatoes during 2018-19. The country exports around 3.5 lakh tonnes of potatoes a year, earning Rs 350-400 crore. India is the second largest producer and occupies a prominent space on global potato map (Rana 2015). India enjoys 12.32 % global share against China (24.17% of world production) and Russian Federation, third largest producer of potatoes, (8.20% of world production) (FAOSTAT 2015). Hence, nearly 45% of global potato production takes place in these three largest potato producing countries. The trend growth rate for potato production during initial 13 years of 21st century was highest in India followed by China and Russian Federation (Rana and Anwar, 2018). Potatoes are grown across India under diverse agro-climatic conditions in almost all States except the coastal belt. Nearly, 82% of potatoes are grown in northern India in the vast Indo-Gangetic Plain (IGP) during short winter days from October to February/March. As there is variation in the agro-climatic conditions of India, there are differential requirements of potato production technologies and frontline extension models. This paper highlights the

experiences to address the issues of potato cultivation in different regions of India and the experiences of various frontline extension approaches.

The major constraints to potato production in the NEH states are: (i) Non-availability and high cost of quality tuber seed, (ii) inadequate availability of inputs like fertilizers and plant protection chemicals, (iii) poor management practices followed by the potato growers and (iv) perpetuation of serious potato diseases like late blight, brown rot, bacterial wilt, viruses, etc. Potato tuber seed in majority of the NEH states is, therefore, regularly procured from distant places of the North levying heavily on the farmers due to long distance transportation of seed tubers and adding to the cost of seed. Besides, there has been acute shortage of the cold stores for potato in the entire NEH region. There are hardly 3-4 cold stores that too only in Assam and Tripura, which are not sufficient enough even to accommodate seed potatoes of all the farmers in these two states. Although the improved Indian potato varieties, viz., Kufri Jyoti, Kufri Megha are being used by the farmers in NEH region, yet local cultivars are preferred for the taste and better storability under ambient conditions. A large number of farmers in the NEH region are, therefore, still using seed mostly of the local cultivars, which they store in their houses until next planting season. Seed tubers thus stored under the warm humid conditions for nearly eight months become shrivelled and physiologically too old by the planting time and result in low yields. Similarly, there are manifold issues in potato from other regions. Corresponding to each issue, on-farm trials and demonstrations were conducted by the team of scientists and accordingly the scalable proven technologies and practices emerged.

Methodological Approach:

The present investigation is basically the synthesis of longitudinal studies conducted across the three agro-ecological regions of the country namely north eastern plain, central plain zone, and western Himalayan region for the period of 1992 to 2017. The studies were mainly related to various approaches applied to application, demonstration and dissemination of the different technologies related to potato production. The study sites were located in Shimla (HP); Patna, Nalanda, Gaya (Bihar); Meghalaya, Assam, Nagaland (NE region) and Kannauj, Farrukhabad and Mainpuri (Central plain zone of Uttar Pradesh) which represented the three regions under analysis. The extension education interventions were mainly in the form of capacity building, institution building, and knowledge empowerment. Similarly, technology applications were done in the form of frontline demonstrations, technology assessment, technology integration, and technology adaptation. Technology dissemination was done using the ICT tools and

other mass media. The results of these interventions helped to consolidate the situation specific paradigms abstracted in the form of various models. In the following subheads, these models are deliberated and substantiated with the relevant research support of the concerned investigators.

Results and Discussion

The experiences emanated over the period of time by frontline extension systems as well as field extension systems have been synthesized under the following sub-heads. The work done by the respective researchers under each model has been deliberated from north eastern (NE), north western hilly (NWH), and central plain (CP) zones of India.

1. Frontline Extension Initiatives by ICAR and SAUs in NE and NWH region:

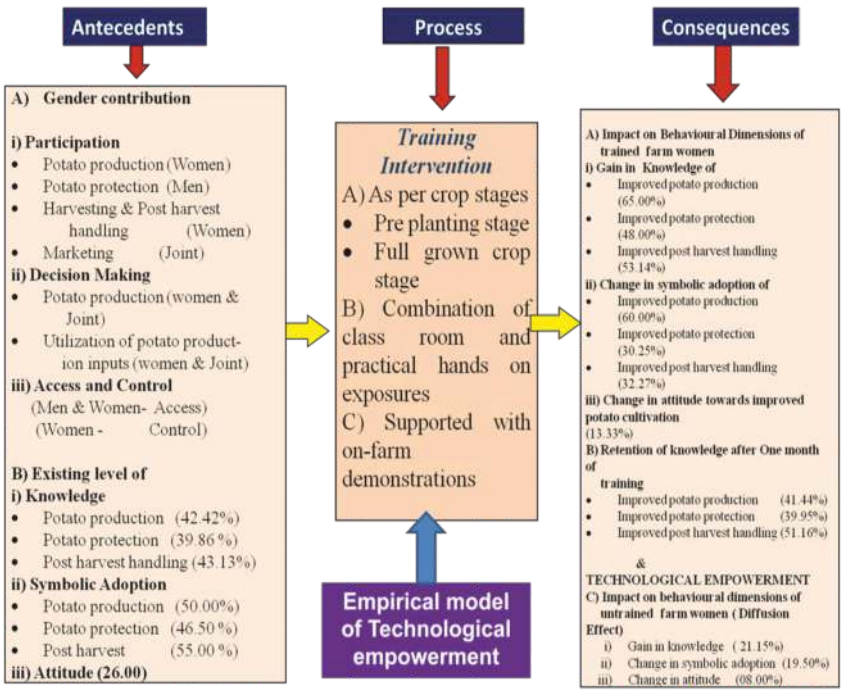
i. Technology demonstrations model: During the period of mid eighties to mid nineties, the new technologies developed by public funded institutions like Central Potato Research Institute (CPRI), Shimla and SAUs have been demonstrating on-farm improved varieties, nutrient management, disease and insect pest management in the contiguous area of the institute and the universities. This model resulted in the yield advantages from 30-80% depending on the technology and the ecology. However, the output was not translated into scale. The impact of the disseminated technologies was also analyzed later on.

ii. On-farm research model: The complexity of farming situations were recognised during mid nineties onward and accordingly the technology assessment and refinement of potato production technologies were done in micro-farming situation perspectives. Farmer participatory researches in farming systems perspective were conducted in Hills and plains ecologies to identify the best fit technological options. The efforts resulted into documentation of best technologies for upscaling by other stakeholders in the given ecologies. Such effort was nationally recognized.

iii. Information empowerment model: The basic idea behind this model was to make the information reachable to unreached especially in the hilly terrains of Himachal Pradesh. Therefore, mass media was utilized for this purpose with need based and situation specific content. Timely and need-based information was considered as the major antecedent for adoption of potato production technologies. As an intervention of mass media, the Radio Pathsaala and Potato School on AIR were planned and implemented. As a result, a large number of audiences were reached simultaneously especially in difficult terrain of hills.

iv. Entrepreneurship development model: Employment creation and income generation of potato farmers were added in this model. Value addition and potato processing were the key component. Products likes chips, potato flakes, badi, etc were prepared by the potato farmers of Hills to generate additional income (200% income advantages over raw potato) and creation of employment (100 additional mandays/year)

v. Technological empowerment model: Tribal farm women were included as the primary stakeholder. Participatory and experiential learning modules were designed and tested as per the crop stages. This approach led to gain in knowledge and symbolic adoption to the extent of 45-76% with very high attitudinal changes. The empirical model has been depicted as below:



Source: Sah *et al* 2008

Mohapatra and Kanungo (2016) reported that Potato Farmers in Odisha had highest Adoption Gap of 30.33 per cent in case of proper use of potato varieties. This gap is attributed to a number of variables like Media Exposure, Scientific Aspirations of Potato Growers, and Higher Consistency in adoption of various production-related technologies of Potato Cultivation.

vi. Gender segregated extension model: The gender segregated roles of tribal men and women farmers were analyzed in NEH region. Activity specific interventions were planned and executed among them. As a result, tribal women specific technologies like seed management, earthingup, harvesting, and storage were steadfastly disseminated. Similarly, tribal men related potato technologies/practices like nutrient management, plant protection measures and marketing were given greater focus (Sah and Kumar, 2007).

vii. Indigenous knowledge based technology integration model: The tradition knowledge of tribals of NEH region were documented and analyzed. This helped to identify the scope for integration of modern technology in their tradition without compromising with the system. Also, the use of tradition practices and materials were validated for their upscaling. As a result, traditional planting method, late blight management, bacterial wilt management, and PTM management were made more effective, cost saving and profit oriented (Sah et al, 2005). Some of the interventions based results are as follows:

I. Refining the traditional method of potato planting: *The case of Meghalaya:* The comparative advantages of refining the farmers' traditional methods of potato cultivation by combining both the recommended and indigenous methods are quite convincing and needs extrapolation.

Table 1: Economics of different planting methods

Methods	Cost of Prodn. (Rs./ha)	Marketable Yield (t/ha)	Gross Income (Rs./ha)	Net Profit (Rs./ha)	B:C
Farmer's Method	74,445.0	31.23	1,87,380	1,12,935	1.52
Refined Method	64,441.0	32.66	1,95,960	1,31,519	2.10
Scientific Method	50,445.0	25.37	1,52,220	1,01,775	2.01
CD 0.05	-	6.50	-	-	-

Source: Kumar *et al* . 2008

ii. Managing the late blight for summer potato: In general, owing to heavy incidence of late blight in summer (March-May), farmers hardly do late blight management. However, prophylactic two spray at weekly interval helped to enhance the crop length by 10-15 days, thereby ensuring the yield advantages of 25-35% and the economics improvement accordingly.

Table 2: Economics of fungicidal spray for late blight management in low land potato cultivation under different cultivation methods

Sl. No.	Treatments	Seed Rate (q/ha)	Multi. rate	Cost of prod. (Rs./ha)	Gross income (Rs./ha)	B:C	Cost Incre. (%)	Inco. Incre. (%)
1.	Farmers' method (control)	50.00	3.6	60,000	1,12,140	1.8	-	-
2.	Farmers' method (Sprayed)	50.00	5.3	64,445	1,65,300	2.6	7.4	47.40
3.	Scientific method (control)	33.33	4.9	39,600	0,86,820	2.2	-	-
4.	Scientific method (Sprayed)	33.33	6.6	44,045	1,14,600	2.6	11.2	31.99
CD		-	1.4	-	-	-	-	-

Source: Kumar *et al*. 2008

iii. True potato seeds as the viable alternative to seed potato: TPS technology is proven to be appropriate to bridge the yield gap in potato at farmer's field. It was evident that TPS technology offered better yield advantage over the popular potato cultivar in the state. It is also suggested to take TPS seedling crop at smaller scale in autumn season and to utilize the obtained seedling tuber as quality planting material in the subsequent cropping season to enhance the production level and minimize the cost of cultivation.

Table 3: Prospects and expected benefits from TPS in the potato economy and environment of NE states

Name of State	Area ('000 ha) under potato	Av. yield (t/ha)	Proposed 1% of the total area (ha) to be brought under TPS	Requirement of TPS (in kg) for 1% proposed potato area	Cost (lakh Rs) incurred on TPS (@ Rs 20,000 /kg)	Saving of fungicides (kg) @ 5 kg Mancozeb /ha (for three sprays)	Saving of quality seed potato (ton)	Tuber let production (ton) (@existing Productivity)	Area (ha) replacement by quality seed (@ 2.5t/ha)
Arunachal	04.30	7.17	043.0	006.45	01.29	0215.0	**108**	0308.30	**0123.32**
Assam	77.83	7.57	778.3	116.74	23.35	3891.5	**1946**	5891.70	**2356.70**
Manipur	04.83	5.24	048.3	007.24	01.45	0241.5	**0121**	0253.10	**0101.24**
Meghalaya	18.17	8.13	181.7	027.26	05.45	0908.5	**0454**	1477.20	**0590.90**
Mizoram	00.43	4.22	04.3	000.65	01.30	0021.5	**0011**	0018.15	**0007.26**
Nagaland	03.97	7.91	039.7	005.96	01.19	0198.5	**0099**	0314.00	**0125.60**
Sikkim	06.80	4.12	068.0	010.20	02.04	0340.0	**0170**	0280.20	**0112.10**
Tripura	05.50	18.53	055.0	008.25	01.65	0275.0	**0138**	1019.10	**0407.60**
Total	**121.83**	**7.86**	**1218.3**	**182.75**	**36.46**	**6091.5**	**3046**	**9561.75**	**3824.72**

Source: Dubey *et al* . 2010

iv. Minimizing the use of chemical fertilizers in hills: Experiences indicated that the technological option of replacing the chemical fertilizers with bio-fertilizers to certain extent (20-25%) helped in cost saving. Besides, the mode of application was found to be less complex to adopt it fully. Many of the secondary and tertiary beneficiaries of this on-farm trial opined that bio-fertilizer treated potato field appeared healthy and relatively lesser infected by late blight and other diseases in comparison to the non-treated field. In addition, all the beneficiary farmers felt that the soil condition was better in bio-fertilizer treated plot for the subsequent vegetable crops as compared to untreated field.

Table 4: Comparative advantages of application of different level of bio-fertilizers in potato

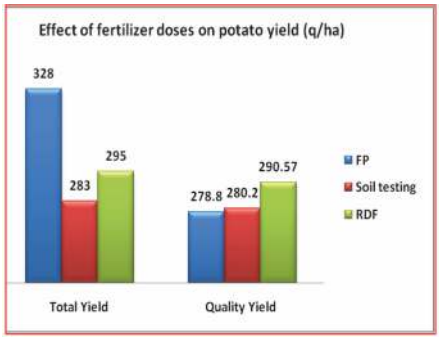
Sl. No	Treatment	Cost of production (Rs/ha)	Gross return (Rs/ha)	B:C ratio
1	100% NPK through inorganic source +10 t/ha FYM (T1)	35,853	1,50360	4.2
2	75% inorganic source +25% organic source + 15 t/ha FYM (T2)	34,430	1,44900	4.2
3	50% inorganic+ 50% organic source + 15 t/ha FYM (T3)	33,007	1,23060	3.7

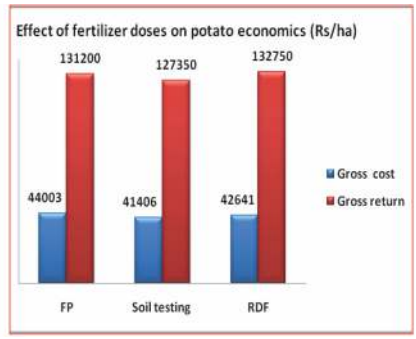
Source: Kumar *et al.* 2005

2. Frontline Extension Initiatives by ICAR and SAUs in central plain region:

In the region, the major stakeholder state is Uttar Pradesh with highest area under potato cultivation in the country. Following major frontline initiatives have been found appropriate for the potato growers of this region:

I. Minimizing the cost intensiveness: The region is catchment of potato production for both the grades of potato. The fertilizer consumption is alarming which is posing threat to soil and water quality. The excessive and imbalance doses of fertilizers are applied @ 250 kg Urea+500 kg DAP+70 kg MOP/ha (200 : 225 : 44 kg NPK/ha) in this zone as against the recommended dose of 327 kg Urea+177 kg DAP+167 kg MOP/ha (188 : 80 : 100 kg NPK/ha). Therefore, site specific nutrient @ of 383 kg Urea+142 kg DAP+116 kg MOP/ha (198: 64: 73 kg NPK/ha) was applied and assessed which gave the results as depicted below:





ii. Potato based sustainable cropping system: The region has numerous potatoes based cropping systems which is sustaining on time and space. Through appropriate interventions of varieties and production practices, the systems are getting more and more profitable and popularized in the region.

Table 5: Potato based preferential cropping systems

S. No.	Cropping systems	Yield of crops (q/ha)			Cost of Prodn (th. Rs./ha)	Gross Return (th. Rs./ha)	B:C ratio
		Kharif	*Rabi*	*Zaid*			
1	Maize-Potato-Maize	32.42	278.08	60.30	130.70	347.64 (IX)	2.7
2	GM-Early Potato-Potato-Maize	-	256.00	64.17	182.15	438.76 (III)	2.4
3	GM-Potato-Maize	-	320.37	67.66	112.90	335.99 (VII)	3.0
4	*Kharif* onion-potato-maize	176.45	252.70	65.66	194.40	426.40 (IV)	2.2
5	Coriander-potato-onion	40.60	296.43	236.29	236.50	640.13 (I)	2.7
6	Maize-Early potato-Summer tomato	33.80	200.53	476.22	188.15	505.71 (II)	2.7
7	*Kharif* G/nut-potato-Summer G/nut	16.72	310.45	32.19	157.00	412.96 (V)	2.6
8	Maize-Potato-Groundnut	35.63	288.76	29.84	146.30	380.30 (VI)	2.6

Roman letter in parentheses indicate rank

iii. Potato based intercropping: The sole potato crop cultivation is no longer seen as the main source of income to the farmers. For augmenting the per unit profitability, number of potato based intercropping have been emerged in the region which makes the potato cultivation more profitable and sustainable.

Table 6: Potato based intercropping – Some indigenous systems

S. No.	Cropping systems	Yield of crops (q/ha)		Cost of Prodn (th. Rs./ha)	Gross Return (th. Rs./ha)	B:C ratio
		Kharif	*Rabi*			
1	Potato + Jasmine	00	80.55 + 208.36	272.15	709.35	2.61
2	Potato + Pumpkin	00	300.00 + 220.00	112.50	280.25	2.50

iv. Seed potato production: This is also an emerging area of business model in potato production of the State. Seed potato produced from this State are exported to north eastern states like Assam, Meghalaya and even to West Bengal. This model made the potato cultivation in the State sustainable.

3. Field Extension by Deptt. of Agri. and Horti.

i. Large scale Technology dissemination: Ensuring availability of potato seed tuber to farmers on subsidized rate and sale of plant protection chemicals for diseases and pest control. Facilitating the marketing and supply chain logistics. Information dissemination using advisories and alerts. These efforts are resulting into increased seed replacement rate in potato, reduced level of disease and insect pest and thus enhancing the potato production in India and also adding to farmers' income by a good marketing and storage network.

ii. Incentivizing the potato growers by Govt. schemes: Offering subsidy on big machinery like potato planters, diggers, tractor sprayers, etc. Ensuring credit facilities to the farmers for the input intensive potato farming. These efforts have helped to enhance potato farmers' efficiency in terms of time, cost and energy resources

4. Specialized Programme through Specific Project Support

Project funding support under NATP (TAR), NATP (HFNS), NATP (CGP), etc. Support by DAC &FW, GOI as Mini Mission for Integrated development of Horticulture in NE states including Sikkim, J&K and Uttarakhand. Support by NABARD and CIP. These project specific supports resulted in evolving various model for large scale upscaling by the line departments and also helped for technology demonstrations, capacity building, social institution building, etc for different set of clients.

Summary:

The synthesis of different models and approaches utilized for dissemination and application of potato technologies in different parts of India clearly indicate that no single recipe could be made valid across various situations. At the same time, even in a given agro-ecology, the

combination of approaches deems appropriate if the felt needs and priorities of the potato growers are to be addressed. Analysis revealed that under the complex and diverse ecology as prevailing in north eastern region, the issue of quality seed use, alternate seed options, disease and insect pest management shall be the priority interventions. In the more hilly region, timely and need-based information accessibility of the potato growers shall be the focus area. In the lesser complex and better resource endowed areas prevailing in the central plain zone, the second generation issues like minimizing the excessive nutrient use, making the potato based cropping system more remunerative and evolving the potato based intercropping for income maximization shall be the major purposes. Authors, hence, comfortably conclude that for the given commodity, the different possible options of technology application models need to be worked out and embedded particularly in agro-eco situations as prevailing in Indian context. Pluralism, therefore, at the micro-level need to be more for extension education methodologies for technology application protocols rather than institutional.

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