

Restructuring Agricultural Research, Extension and Education in Nepal's Federal System

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Abstract

Nepal has adopted three tiers of governments namely federal, province and local from unitary governance structure with the endorsement of new constitution in September, 2015. This transformation in government and governance has apparently led to the need for transmuting functions and functionaries within the governments. Under this circumstance, re-orientation of three pillars of agriculture development namely research, extension and education system and their linkages need to be revised. The paper discusses on how agriculture research, extension and education system and their linkages should be in the changed context of federalism. The unitary linkages have been analyzed at four different thematic levels i.e. policy coordination followed by technology generation, verification and dissemination through the case study of vegetables sector in Nepal. The analysis have been done on how the research and development system has performed in unitary and new federal system of different countries. For the study, three workshops (one at provincial and two at federal level) and seventy key experts' survey were carried out. It was found that, to make the linkage more effective in changed federal structural of Nepal, joint involvement of research, extension and education personals at different levels was necessary. Suggestions have been made on appropriate linkage model for Nepal to suit with newly adopted federal governance system. The proposed model guides how agricultural research, extension and education system could move coherently.

Keywords: *Agricultural research, extension and education linkage, framework, technology generation and transfer, federal system and partnership*

Introduction

Agricultural Research, Extension and Education are interdependent but currently operated independently in many countries including Nepal. Bridging the gap between research and extension for strengthening their linkages is the most serious institutional problem in designing research and extension program (World Bank, 1985). Belay and Alemu (2017) reported that agricultural research and extension carried out by two different bodies with very limited working relationships and contacts has limited the understanding of potentials and constraints of diverse farming systems which are the basis for determining relevant technology. Previous empirical studies in many developing countries have identified weak links between research and extension as one of the major factors limiting the flow of information, technologies and knowledge among different actors to solve the problems (Purcell and Anderson, 1997; Agbamu, 2000; Belay, 2002; Anderson and Feder, 2004; Timsina et al. 2016a). Technology integration and packaging are the weakest parts of the current research-extension interface resulting in poor technology flow, uptake and adoption by the farmers and other clients (Gauchan, 2008). Similarly, the lack of communication between

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research and extension was one of the top problems with Nepal's extension services (Suvedi and McNamara, 2012). Different types of models have been used to analyze the research and extension linkage such as the innovative linkage model (Ponniah et al. 2008), Farmer-back-to-farmer technology generation and transfer system model (Rhoades and Booth, 1982), research-extension interface model (Javier, 1989). When there are more than two partners in technology generation and dissemination, linkage model can be effective to analyze the linkage between research and extension (Sadighi, 2005). Similarly, Paudel and Thakur (2008) used the agro-technology development and transfer model in Nepal. Institutional innovation that promote facilitation, coordination, networking and institutional arrangements and enabling environment for working together with diverse clients and partners in the process of technology development, diffusion, uptake and adoption is utmost (Gauchan, 2008). Effectiveness of research and extension linkages varies from country to country depending on their organizational structures and historical working relationships between them (Agbamu, 2000). Gauchan (2008) reported that in the changed context, national research and extension system in Nepal need to focus more on identification and evolving of innovative methods, which promote continued interaction between research and extension (R & E) including educational institutions, farmers and other informal actors (e.g. traders, rural entrepreneurs, policy makers etc.). Therefore, this study has focused on developing suitable research, extension and education linkages model under the federal system of the country.

Methodology

Institutional and Experts Survey

The institutions under Nepal Agricultural Research Council (NARC) and Department of Agriculture (DoA) implementing vegetable related programs were selected to collect the information. For this, altogether 12 NARC stations and 14 District Agriculture Development Offices (DADOs) were selected. A total of seventy personals from Outreach Research Division (ORD) of NARC, Universities, Ministry of Agriculture and Livestock Development (MoALD), International/National Governments Organization (I/NGOs), Community Based Organizations (CBOs), Regional Agriculture Directorate (RAD), Socioeconomics and Agricultural Policy Research Division (SARPOD), NARC central office, International Rice Research Institute (IRRI) Nepal, Vegetable Development Directorate (VDD), Department of Agriculture (DOA), Seed Quality Control Center (SQCC), seed companies and retired agriculturists were interviewed using semi-structured questionnaire. Moreover, three workshops; one at provincial and two at federal level were organized. During the workshops, papers were presented from experts and interaction was done among different stakeholders. Moreover, secondary information were also collected from literature review.

Analytical Framework

The unitary research and extension linkage was analyzed using model developed by Timsina et al. (2016a) and the analysis was focused on 4 thematic levels namely policy coordination, technology generation, technology verification and technology dissemination with some predetermined major research and extension linkage indicators at different levels. The proposed research-extension-education model was developed to analyze the linkage between research, extension and education in new federal system based on experience received from conventional research-extension linkage in unitary system by taking vegetables sector as a case study, modality used in different federal countries and suggestions received from different workshops and stakeholders. This proposed research-extension-education linkage model was analyzed at all thematic levels considering both horizontal and vertical co-ordination among the actors. In this model, it is assumed that technology verification and dissemination should be done simultaneously for effective dissemination of the technology.

Results and Discussion

i. Unitary research and extension linkage in Nepal: A case study of vegetables sector

The policy level linkage and coordination has been discussed considering the case of public sector vegetable development programs in Nepal. Research has been grossly neglected in mega projects under MoALD for many years. Examples include mission programs, Commercial Agricultural Development Project (CADP) and Project for Agricultural Commercialization and Trade (PACT), where the agricultural development was not properly linked to agricultural research in any stage from initiation to implementation. NARC has started to include experts from different institutions under the MoALD and universities in its scientific proposal review panel since the start of NARC autonomy, but this has not been substantially improved scientist-extension relationship due to low financial incentives provisioned for reviewers and poor commitment from NARC management. Further, these reviewers were not regularly included during implementation of project activities, monitoring or sharing of research outcomes. Next interface is Working Group Meeting that NARC organizes as thematic working group meetings every year with the objectives of identifying major problems and designing the research proposal accordingly for the coming year. Even though the objective of this meeting was to strengthen the research and extension linkage, the number of participants from extension was limited. In some meetings, their participation was limited to inaugural session only. National Agricultural Technical Working Group (NATWG) is another forum where policy makers/top level authorities associated with technology generation, verification and dissemination meet together and provide ways to mitigate the bottlenecks to effective delivery of technology (Paudel, 2010). Agricultural Technical Working Group (ATWG) was designed in 1998 with the support of World Bank funded Agriculture Research and Extension Project (AREP) for strengthening linkage between research and extension at the national level, regional level and district (local) level (ORD, 2000). The approved guideline of ATWG in 2009 envisages that before organizing NATWG, Regional Agricultural Technical Working Group meeting (RATWG) should be organized three times a year; first in Regional Directorate of Livestock Services (RDLS) in first trimester, second in Regional Directorate of Agriculture in second trimester and last in R/ARs in last trimester in each fiscal year (ORD, 2010). Every year the issues raised in RATWG and NATWG were stereotypic. There was limited practice of providing information on intensity and target groups of problems on the raised issues but just a list of problems which were only raised during the workshops. NARC also has not been able to focus on prioritizing the issues and problems considering its limited resources. Similarly, same problems were raised repeatedly on which NARC has already developed and implemented research projects to solve many of those problems and issues.

Horticultural Research Stations (HRS) and Horticulture Research Division under NARC are mandated to generate technologies for vegetable crops and fruits. Vegetables related technologies include improved varieties, breeding lines, production and processing technologies, source seeds and package of technological practices. Among vegetable crops, tomato is one of the important cash crops where maintenance of inbred lines is the most important aspect in tomato breeding to develop hybrid lines and open pollinated (OP) varieties. Hence, HRD (2013) reported that 25 inbred lines were maintained in the year 2012/13. Even though the private sectors have mandate for it, none of the I/NGOs and private sectors are undertaking variety maintenance program in vegetables sub-sector. But, the research stations under NARC are maintaining it. This indicates the gap between research, extension and private sector.

Variety release sub-committee chaired by Director General of DoA comprises about nine members out of which 45 percent are from NARC, 22 percent are from private sector and remaining are from Department of Agriculture (SQCC, 2016). Role of the Chairperson has been limited to proceed meeting rather than to accelerate the technology dissemination and provide regular feedbacks for technology generation. As a result, most of the vegetable source seed are not used for producing quality seeds for subsequent cycles. Hence, it directly goes to fresh vegetable producing farmers without maintaining the seed cycle. It is reported that out of total source seed distributed to farmers, more than 60 % goes to fresh vegetable production. Maintaining proper seed cycle is very important to meet seed requirements and get efficiency in seed cycle which is not happening in Nepal (Timsina et al. 2018; Timsina et al. 2015). After generation of technology at research stations, the verification of technology is done at Outreach (OR) sites of NARC in a participatory way involving research, extension, farmers and all the stakeholders. OR is the interface between research and extension. It is found that out of total verification trials conducted by NARC in

FY 2012/13, about 70% were participated by DADOs and related institutions. But, there was limited involvement of private sector and no involvement of education personnel during the technology verification. Paudel et al. (2007) reported that involvement of all stakeholders in OR sites of NARC are not in full swing.

Communication materials (pamphlet, leaflet, brochure, CD, fact sheet, etc.) of generated technologies are major source of information for technology dissemination. Communication publication and documentation division (CPDD) of NARC along with RARS/ARS/disciplinary divisions and commodity programs has been publishing related booklets/pamphlets and distributing to concern stakeholders. Until 2013, there were about 300 to 7500 pieces of communication materials produced from different offices of NARC in the sample technologies used in the study. The farmers were the major receivers (66%) followed by non-government organization (18%), public extension offices (10%) and students (6%) of these communication materials. This indicates that NARC's linkage to public extension offices for supplying information of proven technologies is low indicating poor linkages with extension system. The practice of further multiplication of such published materials does not exist in extension program, which could be good option to disseminate technology from such a limited number of materials received from NARC. There is no clear-cut mandate to research and extension for integration/packaging of technology generated from NARC, which is utmost necessary for further scaling-up of technology. Also, in the monitoring tour organized by NARC related to vegetables sector, the participation of extension agents was about 50%. Whereas in case of monitoring tour organized by extension offices in this sector the involvement of NARC personnel was only about 17% which is inadequate. In the special problem-solving visits organized by DADOs, the involvement of NARC was found about 50%. Similarly, in case of vegetables sector related training conducted by DADO to fresh producers, the involvement of DADOs was found the highest (69%) followed by RADO and NGO (26%) and NARC (5%). The chi-square test was used to understand the effect of involvement of trainers from NARC. DADO offices were categorized based on presence or absence of NARC offices having vegetables and source seed production program in the respective districts. The result indicated that ($\chi^2 = 2.41, p=0.14$), there were no significant difference in number of trainers involved from NARC. In the district with the presence of NARC research stations, the involvement of researchers in training conducted to farmers by extension was found very weak while it was almost none in case of the districts where there was absence of NARC research stations. These findings indicate poor and irregular linkage of NARC with public agricultural extension system in vegetable crops.

ii. Lessons from different federal and highly decentralized countries

Different federal countries have their own tiers of governmental system. For example, India has 29 states and seven union territories. Within each state, there are four additional layers of sub national government: (1) divisions, (2) districts, (3) blocks, and (4) villages/municipalities where as in Malaysia, there are two tiers of sub national government units that encompass 13 states and 149 local councils. In South Africa there are nine provinces and 843 local authorities. Indonesia has four tiers of local government bodies: (1) provinces (provinsi), (2) districts (kabupaten and kota), (3) sub districts, and (4) villages (desa and kelurahan). In case of Nepal, there are two tiers of sub national government units that include seven provinces and 753 local authorities (Rural/Municipalities and Sub/Metropolitans). The variation in number of tiers of subnational government within the country may be due to population and geographic size of the federal countries (Kyle and Resnick, 2016). The constitution of Nepal has scheduled power for research and development at federal and provincial level whereas for agricultural and livestock extension services, it is extended to local levels as well. Agricultural education is unspecified in the constitution (GoN, 2015). Kyle and Resnick (2016) reported that federal countries like India, Malaysia, and South Africa keep agriculture research and development at federal and provincial level whereas there is variation in vertical distribution of agriculture and livestock extension services. In India it is in state level, in Malaysia both under federal and state level where as in South Africa it is distributed in federal, provincial as well as in local levels.

Different federal countries have been using their own institutional modalities and mandate requirements to make research-extension linkage more functional. In India, Krishi Vigyan Kendra (KVKs) has been operated by Indian Council of Agricultural Research (ICAR). Until 2017, ICAR has established a total of 680 KVKs under different host institutions like ICAR Institutes, Deemed Universities (DUs), Public Sector Undertaking (PSU), State Governments, Other Educational Institutions (OEI) and Non-Government Organizations (NGOs) which aims at

assessment, refinement, demonstration and large scale adoption of technology/products through various activities (Rohit et al. 2017). Kyle and Resnick (2016) reported that to make the agricultural extension services more effective in India, the federal government implemented Agriculture Technology Management Agency (ATMA) as the flagship initiative with the support of World Bank in some selected districts in 1998 and was expanded to all districts in India in 2010. ATMAs are registered in all districts of India that bring together researchers, extension workers, farmers, and other stakeholders to develop a demand-based district-level extension plan. Majority of public agricultural extension workers are employees of either the federal ICAR system through KVKs or the state departments of agriculture (Kyle and Resnick, 2016). Qamar (2013) reported that extension research officers at the federal level are required to spend 30 percent of their time to technology transfer activities to make agricultural research and extension linkage more effective in Malaysia. In Indonesia, Assessment Institutes for Agricultural Technology (AIATs) concentrating at the provincial level- is responsible for training agricultural extension workers and ensures that agricultural extension and research are closely linked and integrated into a single structure. It encourages participation in the planning of provincial agricultural research activities carried out by extension workers, farmers' groups, private sector, and other community organizations. Coordinating and overseeing among AIATs has been doing by the Indonesian Center for Agricultural Socio-Economic Research and Development, housed under the Indonesian Agency for Agricultural Research and Development (IAARD), which is housed under the Ministry of Agriculture (Kyle and Resnick, 2016).

iii. Suggested model for Research, Extension and Education linkages in federal system

Based on the assessment of conventional R-E-E linkage, schedule of powers provided by constitution across three tiers of government, lessons from case study of research-extension-linkage of vegetable sectors, review of governance of agricultural R&D across some federal countries, an alternative agriculture research, extension and education linkage model has been proposed for Nepal's new federal system (Figure 1). In the proposed model three different thematic levels comprising policy level coordination, technology generation, and technology verification and dissemination are focused.

Policy Coordination

Different tiers of government in Nepal have authority over different elements of agriculture with the endorsement of constitution in 2015, which require high levels of horizontal and vertical coordination (Kyle and Resnick, (2016). Since research requires engagement with a diverse array of stakeholders, ranging from the private sector to multiple ministries involved in agriculture, it should not be controlled by one line ministry (Byerlee and Alex's, (1998). Therefore, horizontal policy coordination is required among the agriculture related line ministries. It can be maintained and improved through the use of National Planning Commission. Similarly, coordination among Nepal Agricultural Research Council (NARC) here after known as proposed Department of Agricultural Research (DoAR)², Department of Agriculture (DoA), Department of Livestock and Fisheries (DoLF), National Seed Board (NSB), National Farmers' Commission (NFC) and educational institutes can be maintained and improved using several mechanisms. This proposition of DoAR is the outcome of the wide scale consultation with scientists, retired NARC professionals and other stakeholders. Previous findings of the study in NARC have indicated that there is a need to restructure in the governance system in NARC to make it more competitive and inclusive in the changed context (MoAD 2014; Gauchan and Paudel, 2012; SAS, 2011; Paudyal, 2011). Further, the three-year Interim Plan (2007-2009) of the Government of Nepal specifies the restructuring of NARC to make it more dynamic and effective in the country. NARC presently does not have full autonomy as envisaged in NARC act (1991) in one hand and in another hand NARC act needs to be amended to meet emerging research issues (Gauchan and Paudel, 2012). Similarly, NARC has been facing problem of leadership instability due to political changes and interferences in the last 2-3 decades. Moreover, role of NARC has not been very effective due to detachment with mainstream government system for policy decisions, easy access to government resources, donor projects and linkages with government departments (Gauchan and Paudel, 2012). Therefore, reposition of NARC structure in the mainstream

² DoAR is proposed Department of Agricultural Research after restructuring of NARC. So the word NARC or DoAR may be used here interchangeably

government body after establishment of Department of Agricultural Research (DoAR) is necessary.

Activation of National Agriculture Technical Working Group (NATWG), creation of liaison unit/linkage and coordination section in different institutions, rigorous review for scientific research proposals and assessment of variety/breed release, seed/breed certification, seed balance sheet development and technology certification and release at national level, , bimonthly meeting of DGs (DOAR, DOA, DOLS and Universities), co-ordination among different stake holders for curriculum development (for post graduate level) for deemed- to- be university and agricultural institutes/colleges/universities are different mechanisms for policy co-ordination. In India, ICAR has periodically been appointing Deans' Committees for revision of course curriculum of all the agriculture universities in India. The updated curricula have been restructured to underpin relevant practical skills, entrepreneurial aptitude, self-employment, leadership qualities and confidence among graduates, attracting and retaining youth in agriculture; thus provide academic legitimacy to the new and emerging issues of food and agricultural system, and contextualize the new pursuits (ICAR, 2017). Further, other mechanisms could also be sought. In case of NATWG and DGs bimonthly meetings, provision should be made to include representatives from universities which are lacking in the present context. Involvement of research, extension and related educational stakeholders are required right from the beginning of designing mega R & D projects or mission programs. The role of each actor should be specified in these programmes and projects. Provision of separate Secretary for Agriculture Research among senior and competent scientists is utmost at the central level to co-ordinate the agricultural research, development (extension) and education and national agricultural research system in the country. Moreover, it is also relevant for maintaining international linkages, coordination with high level bureaucrats and ultimately for stability of leadership in Agricultural research system of Nepal. This position should be fulfilled according to the proposed organizational re-structuring by NARC from present autonomous body as a separate AGRICULTURAL RESEARCH GROUP under AGRICULTURAL SERVICE of government of Nepal. Gauchan and Paudel (2012) also suggested that Executive Director of NARC should be Ex-officio Agricultural Secretary (Research) of MoALD with a well-functioning Agricultural Research Secretariat.

Vertical policy coordination can be maintained through establishing and coordinating National Agriculture Technical Working Group (NATWG), Provincial Agriculture Technical Working Group (PATWG) and sub-provincial Agriculture Technical Working Group (ATWG). NATWG should include representatives from PATWG and PATWG should include representative from sub-provincial Agriculture Technical Working Group (ATWG) and Local government while conducting their technical meetings. As earlier provisioned, NATWG should be organized by proposed DoAR. Likewise, Agriculture Technical Working group at provincial level (PATWG) should be conducted by Directorate of Livestock and fisheries, Directorate of Agriculture and proposed Directorate of Agricultural Research in first, second and third trimester, respectively at each province. The Agriculture Knowledge Center (AKC) should organize ATWG at sub-provincial level. It is recommended that all ATWG meeting should be conducted for two days with the participation of all related stakeholders (research, extension, education, private sectors, farmers/entrepreneur's and other development partners) at each level with intensive discussion.

Agriculture may not be prioritized by local governments or communities, requiring attention to budgeting mechanisms (IFPRI, (2016). So, policy guidelines should be developed by central government regarding budget prioritization and allocation for provincial as well as local level (example, mandatory provision of allocation of certain percentage of budget in agriculture sector). But the provincial and local government can allocate agricultural budget based on their interest/need. Coordination should be maintained while hiring extension staffs for local government from provincial public service commission to ensure connectivity of authority and accountability among them. IFPRI (2016) reported that extension staffs are responsible to local government but provision of hiring through the provincial public service commission might create a disconnection between authority and accountability.

Technology Generation

Horizontal coordination among different stakeholders such as Research Institutes (RIs) under DoAR, International Agriculture Research Systems (IARS)/Donors, International /Non-governmental Organizations (I/NGOs), Federal Educational Institutes, resource centers of breed and seed companies is necessary for the agricultural technology generation in Nepal. The proposed DoAR should lead and act as National Agriculture Research Systems (NARS)

with similar role of NARC. Agriculture Development Strategy has recommended to include five research Institutes such as National Agriculture Research Institute (NARI), National Animal Science Research Institute (NASRI), National Horticultural Research Institute (NHRI), National Animal Health Research Institute (NAHRI) and National Aquaculture and Fisheries Research Institute (NAFRI) during restructuring of NARC. Among three key objectives of NARC Act 1991, two are focused on research while the third objective is to support Government of Nepal in formulating agriculture policy but the need and importance of policy research institute was not mentioned in ADS. But recently, the importance of Agriculture Policy Research Institute has been realized and accordingly it is suggested to establish policy research institute under proposed DoAR. One Deemed to be University under DoAR needs to be established linking with national research institutes such as NARI and NASRI including proposed NHRI, NAHRI, NAPRI and NAFRI. In India, Indian Agricultural Research Institute under ICAR is the largest institute in the system with mandate of Deemed University, followed by the Indian Veterinary Research Institute. Each of these, along with two other research institutes, also have the status of deemed universities. In general, those four institutes focus on agricultural research, while the project directorates play a coordinating role between the institutes and the state agricultural universities. At the state level, state agricultural universities are responsible for agricultural research and education specific to state needs (Kyle and Resnick, 2016). In continuation to the discussion between Agriculture ministers of India and Nepal in June 2018, Joint Agriculture Working Group (JAWG) meeting between Nepal and Indian agreed to establish Deemed to be University under NARC which was held on 16-17 August, 2018. On request of Nepal side, Indian side agreed to send the team of experts for preparing PDR until October 2018 (JAWG Agreement, 2018). Establishment of Deemed-to-be University under NARC or proposed DoAR is important to improve the quality of research as well as to develop quality human resources. It also increases efficiency in the use of existing infrastructure and qualified human resources. Establishment of Deemed University is essential for research- education linkage and technology transfer by combining and coordinating all the national research institutes (Gauchan, 2014). CGIAR and other IARC/donor support are needed in technology generation via financial and technical support. The Institutions under CGIAR have direct link with NARC (Paudel et al. 2007). I/NGOs participation are also important in technology generation but that should be in coordination with DoAR. Involvement of private sectors for technology generation in partnership approach is also critical for the commercialization of the technology. In view of the recent need to meet the demand for foundation seed, NSB has decided that it can be done even by private seed companies with the approval from NSB. Nevertheless, it requires the private party to fulfill the minimum terms and conditions set by the NSB (NSB, 2007). This provision has opened-up new opportunity to private sector to involve in technology generation and commercialization. However, none of the private companies are following all terms and condition set by NSB due to poor linkage of research with private sectors and extension agencies. From 2011, realizing the need of seed demand of Shrijana (hybrid tomato released in 2010), commercial seed production was initiated in a public private partnership (PPP) model (Gairhe et al. 2016).

ADS has envisioned to introduce competitive research grant support under NARC (proposed DoAR) through National Agriculture Research Fund (NARF) to better integrate NARC and NARDF competitive research grants and make inclusive for participation of stakeholders outside of NARC/public research system. Gauchan (2014) reported that Agriculture Research is public good and it should be primarily funded and managed by central government but access of private sector participation and decision making should be increased. Joint review and planning meeting between resource centers of extension and planning directorate of NARC (proposed DoAR) including participation of other stakeholders is important for the resource allocation and prioritization of technology generation. Horizontal coordination among different agricultural research stations (ARSSs), agriculture research directorates (ARDs), national commodity programs (NCPs), seed companies and provincial educational institutes is also important for the provincial level technology generation. Research problems and priority may be different in different province. Therefore, the effective coordination between provincial ministry of land management, agriculture and cooperatives (PMoLMAC) and ARD/ARS/NCP is important. Shared research mechanism³ can be introduced between PMoLMAC and ARD/ARS/NCP to solve the provincial specific research problems. Different research expertise from different commodity/research program based on necessity should be used as

³ Shared research mechanism means Provincial ministry provide financial support to research organizations (PARD/ARS/CP) and research organization provide solution to the problem based on mutual understanding

commodity/priority may change over time in different provinces. Separate liaison units should be established in each PMoLMAC and ARD for effective coordination. For better linkage with education in technology generation, mechanisms need to be developed to uptake regular interns (students) from educational institutes in ARS/ARD. There should be periodic curriculum update of educational institutes (provincial issue specific) in coordination with Deemed to be University for better linkages and improvement in practical education. Provincial seed companies should also be involved to generate technology in partnership with ARS/ARD/NCP.

Vertical coordination among proposed research institutes under DoAR, ARD, ARS, local government and Outreach (OR) site is necessary for technology generation. The generated technology at different research stations has been under testing in OR sites at present. Outreach Research Division (ORD) of NARC has been mandated to coordinate outreach research activities in more than 50 OR sites under command areas of Regional/Agricultural Research Stations (R/ARS) in various agro-ecological domains across the country. But, there is gap in co-ordination which must be strengthened. OR sites are playing viable role for increasing number of high adopters (farmers) compared to non-OR site farmers (Timsina et al. 2016b). Farmers at OR site are adopting technologies rapidly compared to non-outreach site and are getting additional income at outreach site (Timsina et al. 2012; Shrestha et al. 2012). Therefore, it seems that the number of OR sites must be increased targeting different ecology for rapid dissemination of technology. . It is suggested to allocate adequate fund by local government to carry out research activities to generate technologies in their priority areas and ARS/ARD/NCP should allocate sufficient resources to carry out such researches on locally prioritized issues, needs and demands of the farmers.

Technology Verification and Dissemination

Strong horizontal coordination among ARS, ARD, NCP, Educational Institutes, PMoLMAC, Provincial Directorate of Agriculture (PDoA), Agribusiness Promotion and Training Center (ABPTC), Livestock Service Training Center (LSTC), Agriculture Knowledge Center (AKC), Veterinary Hospitals, Livestock Service Expert Center (VHLSEC), Private Service Providers (Agro vets, Insurance company) is required for the technology verification and dissemination after generating technology from research organizations.

Several functional linkage mechanisms can be used for the effective horizontal coordination among related stakeholders for effective technology verification and dissemination. Scientists managed on-farm participatory trials e.g. Co-ordinated farmer's field trials (CFFT), Front line on-farm research and demonstration (FLRD) and Farmers acceptance test (FAT) should be conducted at OR sites by respective ARSs of NARC or proposed DoAR, where all stakeholders involved in research, extension, education and private service providers should participate. The participation must be made mandatory. It is reported that two-thirds of DADOs and DLOs wish that the technical staffs in their districts could be more involved in adaptive research, for example, testing technologies in the field (IFPRI, 2016). Similarly, the proven technologies derived from scientists managed participatory on-farm research should be further validated and out scaled through large scale testing of technologies (farmers managed condition) by AKC/ VHLSEC with technical back-up and monitoring from ARD/ARS/NCP. Sometimes, linkages cannot be made effective unless the target is tied up. Scientists of various subject matters (either from ARS, ARD, NCP, and Research Institutes) should be involved to provide ToT (training to trainers) to extension personals working at AKC, VHLSEC, zone, super zone and other offices in coordination with ARD, ABPTC and LSTC. But the target should be fixed earlier in coordination with provincial and local level extension organizations. Moreover, it is also suggested to provide trainings (medium and long term) directly to farmers/entrepreneurs by research directorate/stations for developing their entrepreneurship and scaling up their business through adopting innovative technologies. At present, there is no clear role and mandate of research and extension organizations on integration and packaging of technologies and technical solutions that can help farmers to solve their problem effectively and efficiently at one time (Gauchan, 2014). Therefore, at first, publication of generated technology package by research organization and their multiplication (technology package) by extension offices such as ABPTC/AKC/VHLSEC would be most effective for wider distribution. Small technology kit distribution from AKC/VHLSEC at wider scale is necessary for quick dissemination of technology. Sapkota et al. (2017) also reported that small size mini-kits of rice was found effective for seed dissemination compared to the larger ones. Moreover, farmers' willingness to take risk of adopting a new variety as measured by the seed utilization index was higher with smaller size mini-kits as compared to larger ones. However, wider dissemination and adoption of mini-kits and other technological kits

depends on regular interaction between research and extension system. Therefore, ATWG at sub-provincial level should be organized two times a year (summer and winter) representing key stakeholders from research, extension, education (provincial), private service providers and farmers representatives. Involvement of both research and extension during program planning of agricultural interventions is utmost for effective program implementation. One of the important outputs of program planning is development of seed balance sheet at the provincial level for at least 3 years in advance through involvement of related stakeholders. Foundation seed and certified seed multiplication should be done by AKC/VHLSEC using farmer's group/cooperatives and individual leader farmers for wide dissemination of new seed technologies. Similarly, National Seed Company and private seed companies can also produce foundation and certified seed through maintaining proper seed cycle as envisioned by Seed vision (MoAD, 2013) for wide scale dissemination. Timsina et al. (2018; 2015) reported that current level of production of breeder seed of some crops such as Wheat and Tomato is enough to cover total production area in Nepal if proper seed cycle is maintained.

Mechanism should be developed for professional internship of undergraduate agricultural students from provincial educational institutes during technology verification and dissemination in addition to their linkage with educational institutes and building their capacity. Awareness raising through farmer's institutions are more likely to enhance adoption of existing agriculture insurance schemes in Nepal (Ghimire et al. 2016) which can be used for wide scale farmers to farmers dissemination. Therefore, AKC/VHLSEC should play vital role for linking agri-entrepreneurs and farmer's group/cooperative with agriculture insurance companies for risk management in Agriculture. Similarly, horizontal coordination among agriculture or livestock development section, agriculture or livestock service centers, community agriculture extension and service centers (CAESC), community based organizations (CBOs), seed companies, farmers group/cooperatives and private service providers is critical to disseminate technology to the farm level. Agriculture or livestock development sections and agriculture or livestock service centers can actively participate to distribute technology kit to farmers and providing training to farmers and agro-entrepreneurs. Newly recruited research and extension personals should provide with technical training for short period. SMS or technicians of AKC/VHLSEC and ASC should receive the training periodically from research institutes to update the technical know-how. Farmer's group/ cooperative /private service providers should involve in seed / breed multiplication. Private Service providers such as agro-vets can be used for technology dissemination. Different innovative approach of extension such as use of mobile applications, ICT tools, mass communication media, exposure visit and field days can be used for technology dissemination. The promotion of user friendly ICT between public research and extension as well as among diverse stakeholders such as private sector, farmers, rural innovators and NGOs will have potential role in bridging the gaps in both technical and institutional innovation (Gauchan, 2008).

Vertical coordination between RIs, NCP, ARD, ARS, OR sites, AKC/VHLSEC and agriculture farm/centers is required for technology verification and dissemination. This can be maintained through providing training to subject matter specialists of AKC, VHLSEC, zone, super zone and mission programs, involvement of AKC/ VHLSEC/ ADS/ASC/LSC personals in OR site activities and research scientists in development activities, receiving feedbacks to RIs, ARD, ARS from AKC/VHLSEC/ADS/ASC/LSC through ATWG at sub-province level/PATWG and other coordination meetings. Agriculture farm centers /Resource Centers of DOA/DoLFS should monitor technology disseminated and service provided by AKC/VHLSEC and provide feedbacks to research. Similarly, monitoring from research institutions is needed in large scale technology testing conducted by AKC/VHLSEC/ADS/ASC/LSC. Activities of ARD should be monitored by RIs and those of ARS by PARD. Farm center managed by extension should focus on seed/breed/saplings multiplication and technology demonstration and verification in coordination with research system. Subject matter specialists of AKC/ zone/super-zone/VHLSEC/mission programs should provide training to technical staffs of ADS/LDS/ASC/LSC before providing training to farmers on new technology. Focus should be given to develop community agriculture extension service centers (CAESC) at each ward level as per the provision of ADS (2015-2035) and establish vertical coordination with ADS/LDS/ASC/LSC and other service providers. This is also envisaged by newly formulated ADS in Nepal but its functional modality in federal structure was not clearly mentioned (MoAD, 2014). One of the approaches may be use of group/cooperative/community club as a service center at local level for its sustainability. The farmers /entrepreneurs from service centers can directly be connected to farmer call centers for solving their problems and updating newly generated technology. I/NGO can play important role in providing technical and financial support to agri-entrepreneurs/farmers through CBOs in coordination with local units.

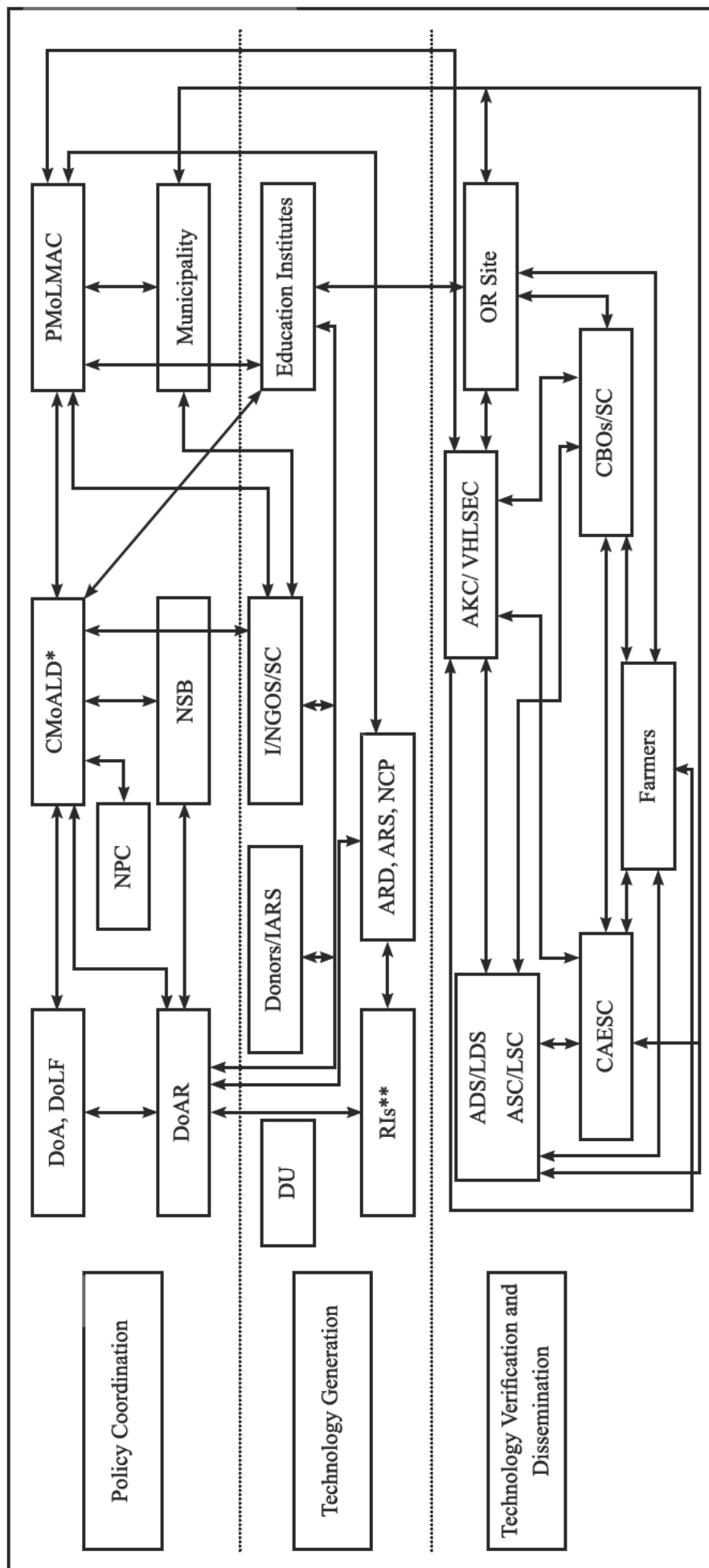


Figure 1 Proposed Agricultural Research, Extension and Education Linkage Model in Federal System

Note: Central Ministry of Agriculture Livestock Development (CMoALD)*= Secretaries (Agriculture, Agriculture Research), Department of Agriculture (DoA), Department of Livestock and Fisheries (DoLF), Department of Agricultural Research (DoAR), International Agriculture research system(IARS), National Seed Board (NSB), Provincial Ministry of Land Management, Agriculture and Cooperatives (PMoLMAC), International /Non-Government Organizations(I/NGOs), Seed Companies (SC), Agricultural Research Station(ARS), National Commodity Program (NCP), Research Institutes (RIs), Deemed to be University (DU), Agriculture Research Directorate (ARD), Agriculture Knowledge Center (AKC), Veterinary Hospitals and Livestock Service Expert Center (VHLESEC), Outreach Research Site (ORS), Community Based Organizations(CBOs), Agriculture Development Section (ADS), Livestock Development Section (LDS), Agriculture Service Center (ASC), Livestock Service Center (LSC), Community Agriculture Extension Service Center(CAESC); Research Institutes (RIs)**= National Agriculture Research Institute (NARD), National Animal Science Research Institute (NASRI), National Horticultural Research Institute (NHRDI), National Aquaculture and Fisheries Research Institute (NAFRI) and National Agricultural Policy Research Institute (NAPRI); National Peasants Commission (NPC).

Conclusion and Policy Implications

There are different views of R&D professionals and planners in the current form of research and extension linkage. But most of them are of the opinion that there is no or poor linkage between research, and extension as they are implemented independently by separate organizations. The first part of the study tried to analyze this unitary research and extension linkage at four different thematic levels comprising policy coordination, technology generation, technology verification and technology dissemination. The study shows that the present mechanism for linkages between extension and research requires substantial amount of commitments and efforts for effective functioning at different hierarchical levels. Therefore, innovative model of research, extension and education linkage in the new federal system has been proposed by closely integrating research system (NARC) within the formal entity of Ministry of Agriculture and Livestock Development (MoALD) and developing both vertical and horizontal linkage and coordination between research, education and extension system at central, provincial and local level. Hence, provision should be made to have a separate agriculture research secretary at MoALD to make policy level coordination more effective. Role of NARC has not been very effective due to its detachment from mainstream government system for policy decisions, easy access to government resources, and donor linkages with government departments. Similarly, it does not have full autonomy as envisaged in NARC Act (1991) and has been facing problem of leadership instability due to political interferences. Advocating restructuring of NARC, conversion of NARC to DoAR is recommended based on overwhelming demand of research scientists and need of the country based on research evidence of weak functional linkage among research, extension and education in the present modality. Establishment of Deemed- to- be University under NARC or proposed DoAR is important to improve the quality of research as well as to develop quality human resources in the country. It will also increase efficiency in use of existing infrastructure and qualified human resources. The effective partnership of research with reformed extension and education system is needed based on their clear roles and responsibilities and monitoring mechanism among the different actors from policy coordination to technology dissemination in different tiers to meet the needs of the farmers and agro-entrepreneurs. The study suggests that more functional linkage is required at technology verification and dissemination for rapid dissemination of the technology. Several functional linkage mechanism can be used for the effective horizontal coordination among related stakeholders from problem identification and prioritization to technology verification, dissemination and scaling-up. In order to strengthen research-extension linkages Scientists managed participatory on-farm trials should be conducted at OR sites with the involvement of all stakeholders involved in research, extension, education and private service providers. Large scale testing (farmers managed condition) should be conducted by leadership of extension organizations such as AKC/VHLSEC with technical monitoring from ARD/ARS/NCP. Research scientists should involve to provide ToT (training to trainers) to all subject matter specialists in coordination with ARD, ABPTC and LSTC. Publication of generated technology package by research organization and their multiplication by extension offices would be most effective for wider distribution as currently there is no clear role and mandate spelled out regarding integration and packaging of technologies and technical solutions that can help farmers to solve their problem effectively and efficiently at one time. Small technology kit distribution from extension organizations (AKC/VHLSEC) developed and validated by research organizations (NARC) in partnership with diverse stakeholders at wider scale is equally important for quick dissemination of technology. Such linkage mechanisms and recommendations will help to developing appropriate linkage model for Nepal to suit with newly adopted federal governance system so that agricultural research, extension and education system could move coherently.

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