

Reforming Agricultural Extension System in Nepal: What can we adopt from selected Agriculture Led Countries?

Krishna Prasad Timsina¹*, Sanjiv Subedi¹, Sunita Pandey², Deepa Devkota¹, Aabhash Aryal and Jeevan Lamichhane³

¹National Agricultural Policy Research Centre (NAPREC), Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal; *krishnatimsina2000@gmail.com;  <https://orcid.org/0000-0003-4005-7039>, SS: sanjiv.subedi@gmail.com, DD: deepadevkota01@gmail.com, AA: artistaabhash@gmail.com

²Prime Minister Agriculture Modernization Project (PMAMP), Khumaltar, Lalitpur, Nepal; SP: pandey.sunita2009@gmail.com

³National Agricultural Technology Information Centre (NATIC), Nepal Agricultural Research Council (NARC), Nepal; JL: jeevanlamichhane7@gmail.com

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ABSTRACT

This paper compares the existing Nepalese agricultural extension system with other selected agriculture-led countries to explore the needs and opportunities of introducing an innovative agricultural extension system in Nepal. A review of various documents including journals, reports, and policy papers was carried out. The status of financial and human resources in agricultural extension of Nepal was assessed from 753 municipalities and 7 provinces through survey interviews and, additionally, expert consultations were done with 15 key personnel working in the field of agricultural extension in Nepal. We examined the major changes in the agricultural extension made before and after the federalization in Nepal and examined institutional arrangements and activities for agricultural sector governance after federalization. Further, three cases were selected from selected agriculture-led countries based on the working modality of research and extension either solely or jointly or in hybrid mode. The study found insufficient human resources for agriculture sector governance especially in provinces and municipalities with 37.4% and 29% of vacant positions, respectively. The recruited agriculture technicians were mostly engaged in administrative management and handout distribution rather than agricultural technology transfer. Most technicians were freshly recruited without any on-the-job training. The paper discussed about the agriculture extension approaches, service mechanisms and structure across the countries, and its relevancy in Nepal. Irrespective of operational modality of research and extension, technological advancement and application of Information Communication Technology plays an important role for the effectiveness of the extension services.

Keywords: agricultural extension system, governance, federal system, local government, human resources

सारांश

कृषि प्रसारको उपयुक्त मोडल पहिचान गर्नका लागि नेपाल लगायत अन्य कृषिमा उन्नती गरेका केहि देशहरुको कृषि प्रसार प्रणालीको तुलनात्मक अध्ययन गर्ने यस कृतिको मुख्य उद्देश्य रहेको थियो। जर्नल, प्रतिवेदन, कार्यपत्रहरुको अध्ययन र समिक्षा गरिएको थियो। कृषि प्रसारको वर्तमान कार्यन्वयन अवस्था, बजेट, मानव संसाधन र नविनतम कृषि प्रसार मोडल अध्ययन गर्नका लागि ७ प्रदेश लगायत ७५३ पालिकामा सर्वेक्षण गरिएको थियो। यसका साथै सम्बन्धीत १५ जना बिषय विज्ञहरुसंग विस्तृत छलफल गरिएको थियो। यस अध्ययनलाई थप फलदायी बनाउन, कृषि अनुसन्धान र प्रसारको कार्य मोडालिटी एकल वा संयुक्त वा हाइब्रिड रूपमा गरिएको आधारमा तीनवटा केसहरु चयन गरिएको

थियो। संघिय गणतन्त्र अधि र पछि कृषि प्रसारमा भएका मुख्य परिवर्तनहरु, कृषि क्षेत्रको सुशासनको लागि संरचनात्मक व्यवस्था जस्ता पक्षको सुक्ष्म अध्ययन पनि गरिएको थियो। अध्ययनबाट प्रदेश र पालिकामा कुल दरबन्दीको क्रमशः ३८% र २९% रिक्त रहेको पाइएको छ। त्यस्तै गरि उपलब्ध मानव श्रोतसाधन प्रविधि हस्तान्तरणमा भन्दा पनि प्रशासनिक कार्य व्यवस्थापनतर्फ उन्मुख भएको पाइयो भने स्थानियस्तरमा पनि प्रविधि हस्तान्तरणलाई प्राथमिकतामा राखिएको पाइएन। स्थानियस्तरमा भर्ना गरिएका प्राबिधिकहरु धेरै जसो भर्खर अध्ययन सकेका र तालिम प्राप्त नभएको पाइएको छ। यस अध्ययनले छनौट गरिएका विभिन्न देशहरुमा अपनाइएका मुख्य कृषि प्रसार पद्धतिको नेपालमा सान्दर्भिकता लगायत कृषि सेवा दिने संरचनाको समेत अध्ययन गरेको थियो। कृषि अनुसन्धान र प्रसारको कार्य मोडालिटी भन्दा कृषि प्रसार सेवाको प्रभावकारिताको लागि प्रविधि विकास तथा सूचना संचार प्रविधिको प्रयोग महत्वपूर्ण पाइयो।

INTRODUCTION

Agricultural extension disseminates technical knowledge, transfers improved technology and provides advisory services to farmers and end users which accelerates agricultural growth (Aker 2011). It is a powerful tool to break the cycle of low agricultural productivity and transform agriculture-based economy to industry-based economy. Extension services are among the most important rural services in developing countries (Faye 2005). A wide range of extension systems have been adopted to deliver agricultural extension services around the world. However, selection of effective and efficient system is crucial to meet the demand of growing commercial farmers. Agricultural extension strategies in developing countries have been built on traditional, top-down approaches that rely on “transfer of technology” models, inflexible packages of recommended inputs, practices and learning methods that lack understanding of how farmers learn and innovate (Davis and Franzel 2018). Before federalization, top-down extension system was practiced in Nepal, the government provided the Agricultural Extension Services (AES) through agricultural extension offices at district level and their service centers and sub service centers along with various commodity-specific farms and regional training centers (Rai and Sharma 2018). AES tend to be under immense pressure to turn out to be more responsive, to become more effective and less costly to the government (Subedi and Kaplowitz 2016).

Nepal entered into federalization after the promulgation of democratic, republican and inclusive constitution in 2015. The constitution has established three levels of government—federal, provincial, and local with shared rule and self-rule. The Local Governments (LGs), represented by 753 rural, sub metropolitan and metropolitan municipalities, are supposed to be the government reaching the door steps of the grassroots people and communities. Regarding governance of the agricultural sector, the constitution of Nepal 2015 has given shared responsibility to all three levels of government. Development of national agricultural policies, laws, standards, regulations, international relationship, agricultural trade, quarantine (crop, food, and livestock) and food safety are major responsibilities of the federal government. The broad term "agriculture and livestock development" is the responsibility of provincial government. Agricultural research and education are placed under both federal and provincial governments. Management, operation and control of agricultural extension is in the sole jurisdiction of the local governments along with agro-products management and animal health.

In the present federal structure, there is no functional linkage—both administrative and programmatic—among the three government. They all function independently. The ineffective coordination among the three tiers of government on agricultural development programs and activities has contributed to overlaps, duplications and gaps. Poor institutional set up and lack of technical human resources have further hindered agricultural extension which requires institutional, organizational and functional reform. This paper reviewed the various extension service systems of selected agriculture led countries to compare it with the existing Nepalese agricultural extension system. Extension service systems are defined by the approach of delivery (supply or demand, top-down or participatory), the providers (public or private) and the funding sources (public, private or development agency). Further, the paper explored the need and opportunities of introducing an innovative agricultural extension system in Nepal. The following research questions were considered to obtain the information.

- a) What is the scenario of agriculture extension in Nepal with reference to changes in agriculture sector governance before and after federalization?
- b) What is the most common system of extension service adopted by selected agriculture-led countries?
- c) What will be the likely potential model or models in the context of Nepal?

MATERIALS AND METHODS

This study used both secondary and primary sources of information. A review of various documents including policy documents, journals and reports on agricultural extension service system in Nepal and the selected agriculture led countries (India, China, Indonesia, South Korea, Thailand, Philippines, Kenya and Israel) was carried out to compare and contrast in terms of its relevancy in Nepalese system. The current status of agriculture extension implementation and its possibilities and prospects for innovative agricultural extension system in Nepal were further elaborated through survey in 753 municipalities and 7 provinces, and expert consultations with the 15 key personnel working in the sector of agriculture extension in Nepal.

RESULTS

Scenario of Agriculture Extension Services in Nepal

Nepal's agriculture extension system is recognized as pluralistic in nature and has been dominated by government-sponsored services. Major structural reform in agriculture governance took place in 2018 AD when the country went under a three-tier structure of federalism in 2015. Currently agriculture extension services are carried out by all governments. Agriculture extension at the federal level is performed by commodity development centers and national priority projects, such as Prime Minister Agriculture Modernization Project (PMAMP), Food and Nutrition Security Enhancement Project (FANSEP), Nepal Livestock Sector Innovation Project (NLSIP), Rural Enterprise and Economic Development (REED) Project, Agriculture Sector Development Programme (ASDP), Nuts and Fruits in Hilly Areas (NAFHA) Project under the Ministry of Agriculture and Livestock Development (MoALD) which is the apex organization responsible for national agricultural development of Nepal (MOALD 2022). In the provinces, a Ministry of Land Management, Agriculture, and Cooperatives (MoLMAC) has been established under which the Directorates of Agriculture, Directorate of Livestock and Fisheries, Agriculture Knowledge Centers (AKCs), Veterinary Hospital and Livestock Expert Centers (VHLECs), laboratories and commodity farms have been set up for agriculture extension services and overall provincial agriculture governance. Local governments deliver agricultural extension and other services through Agriculture and Livestock Development Section in municipalities.

Before federalization, Department of Agriculture (DoA) and Department of Livestock Services (DoLS) and their units all over the country provided extension services to farmers. There were 5 regional directorate for agriculture and 5 for livestock, 75 District Agricultural Development Offices (DADO), 75 District Livestock Service Offices (DLSO), 378 service centers and sub service centers under DADO, 999 service centers and sub service centers under DLSO, 12 Livestock related farms and 5 Livestock related regional training centers. Similarly, 43 agriculture related farms, 24 program directorate and program offices, 16 regional laboratories (soil, seed and plant protection), 16 plant quarantine and check posts and 5 regional training centers were under DoA (AITC 2018). The size and scope of department has reduced after federalization. National projects are implemented directly under ministry and found poor coordination with the departments. The major changes in the agriculture extension before and after the federalization are presented in **Table 1**

Table 1: Major changes in the Agricultural extension made before and after the federalization

Characteristics	Prior to 2015	New Constitution 2015
Units of government	National, Development Regions (5), Districts (75), VDCs (3915) and Municipalities (58)	Federal government, Provinces (7), Districts (77), local bodies (753).
Administration of Local Bodies	Appointments by the federal ministry of federal affairs and local development of officials to administer local bodies	Elections at the national, provincial and local bodies. Exclusive legislative powers are granted to the three tiers of government.
Responsibility for agricultural functions	Agricultural policy development at national level and implementation at sub-national level and agricultural extension de-concentrated to District Development Committee (DDC) through DADOs and DLSOs	Agricultural policy development and implementation at both national and sub-national levels and agricultural extension devolved to sub-national government. Agriculture as concurrent power at three tiers. Operational and management of agriculture extension at local level.
Staffing and coordination	Civil service staff at the national, sub-national, and district levels recruited through the National Public Service Commission. Strong coordination along the line of command.	Civil service staff at the provincial and local levels recruited through a Provincial Public Service Commission; federal civil servants continue to be recruited by the National Public Service Commission; local bodies has also provision to recruit the staff temporarily. No line of command over province and local levels Provision of Provincial Coordination Council (PCC) and District Coordination Committee (DCC)

Source: Adapted and modified from Kyle and Resnick 2016; Dahal et al 2020

Similarly, the institutional arrangement for agricultural sector governance after federalization and its major activities are provided in **Table 2**.

Table 2: Institutional arrangements for agricultural sector governance after federalization and its major activities

Government	Ministry and its subordinate offices	Major activities
Federal	<p>A. Ministry of Agriculture and Livestock Development</p> <ol style="list-style-type: none"> 1. Seed Quality Control Center 2. Agriculture Information and Training Center 3. Plant Quarantine and Pesticide Management Centers (x15) <p>B. National Projects</p> <ol style="list-style-type: none"> 1. Prime Minister Agriculture Modernization Project (PMAMP) 2. Food and Nutrition Security Enhancement Project (FANSEP) 3. Rural Enterprise and Economic Development (REED) Project 4. Nepal Livestock Sector Innovation Project (NLSIP) 5. Agriculture Sector Development Programme (ASDP) 6. Nuts and Fruits in Hilly Areas (NAFHA) Project 	<ul style="list-style-type: none"> • Formulate and implement national level agriculture and livestock related policy, programs, act, guidelines and standards • National statistics • Policy, standards, laws and regulations of seed sector • Agro advisory services and capacity development • Policy, standards, laws and regulations for import, distribution, use and management of pesticides • Quarantine of plant and plant products • Commercialization, mechanization and modernization of agriculture and livestock • food and nutrition security of targeted smallholder farming • to strengthen rural market linkages and entrepreneurship ecosystem

C. Department of Agriculture

1. Centre for Crop Development and Agro Bio-diversity Conservation (x2)
2. National Centre for Fruit Development (x5)
3. National Center for Potato, Vegetable and Spice (x4)
4. Center for Industrial Entomology Development (x2)
5. Central Agricultural Laboratory (Soil, Seed and Plant Protection)
6. Center for Agricultural Infrastructure Development and Mechanization Promotion (x1)

- To enhance production and productivity of cereals, fruits, vegetables, potato, spices, honey, mushroom and industrial crop to promote export and substitute import.
- Provide laboratory services (soil, seed, and plant protection) and act as reference lab
- To conserve and promote agricultural bio-diversity including honey bees
- Market infrastructure development and upgrade (Cold room, market, collection center)
- Develop national standard for agriculture machinery and equipment
- Training and workshop for technology transfer
- Support national policy formulation

D. Department of Livestock services

1. Central Veterinary Laboratory (x5)
2. Foot & Mouth Disease & TADS Investigation Laboratory
3. National Avian Disease Investigation Laboratory
4. Central Referral Veterinary Hospital
5. Veterinary Standards and Drugs Regulatory Laboratory
6. National Vaccine Production Laboratory
7. Animal Quarantine Office (x8)
8. National Livestock Breeding Office (x3)
9. National Livestock Resources Management and Promotion (x5)
10. National Animal Feed and Livestock Quality Management Laboratory
11. Rhizobium and Forage Seed Production Laboratory
12. Central Fisheries Promotion and Conservation Center (x3)
13. SAARC-Regional Support Unit

- To enhance production and productivity of livestock sector
 - Surveillance and investigation on various diseases in the field of veterinary medical
 - Investigation and control of specific animal diseases
 - Policy, standards, laws and regulations for import, distribution, use and management of animal and animal related products (animal quarantine)
 - Training and technology dissemination
 - Testing and demonstration
 - Pure breed protection, production and promotion in Fishery sector
 - Production and distribution of hatchling, fry, fingerling through different resource centers (including ornamental fish)
 - Laboratory services (feed quality, disease and parasite diagnosis)
 - Conservation and promotion of local fish
-

Provincial	A. Ministry of Land Management, Agricultural, and Cooperatives 1. Agricultural Development Directorate 2. Livestock and Fisheries Development Directorate 3. Agriculture Knowledge Centers (Koshi: 11, Madesh: 8, Bagmati: 7, Gandaki: 11, Lumbini: 8, Karnali: 9, Sudur-pashim: 9) 4. Veterinary Hospital and Animal Care Specialist Center (Koshi: 8, Madesh: 8, Bagmati: 8, Gandaki: 11, Lumbini: 8, Karnali: 9, Sudur-pashim: 9) 5. Agribusiness Promotion, Support, and Training Center 6. Livestock Service Training Center 7. Fisheries Development Center 8. Laboratories—seed, plant protection, soil (some provinces do not have these) 9. Commodity Farms and Resource Center	<ul style="list-style-type: none"> • Formulate and implement provincial level agriculture and livestock related policy, programs, act, guidelines and standards • Commercialization, mechanization and modernization of agriculture and livestock sector • Subsidy grant, implementation and monitoring • Promote agro and livestock-based industries • Laboratory services and epidemic management • Agricultural extension, training and capacity building • Provincial statistics • Implement and manage conditional and non-conditional federal programs
Local	Agriculture and Livestock Development Section	<ul style="list-style-type: none"> • Agricultural extension • Subsidy grant, implementation and monitoring • Implement and manage conditional and non-conditional federal and provincial programs

Source: Authors compilation, 2023

Institutional Coordination and Linkages

For effective implementation of national, provincial and local level agriculture policies and priorities, functional coordination across tiers is essential. Coordination and Co-operation have been emphasized in Nepalese federalism. According to the federal, province and local level (coordination and interrelationship) act 2020, two coordination mechanisms are provisioned to coordinate development including agricultural activities under federal, provincial, and local governments through Provincial Coordination Council and District Coordination Committee. However, the mandate of both the council and committees are very broad, and it seems unlikely that they are sensitive enough to see agriculture extension service-related problems in the face of more immediate and prioritized larger political, administrative, and financial issues. Because of such weak vertical and horizontal coordination mechanisms there is difficulty in implementing national policies, difficulties in technology transfer and capacity development of human resources, harmony in regulation and problem in national statistics.

Co-ordination also needs to be enhanced between agriculture extension and research organizations for technology transfer. Before federalization, coordination efforts have been set up between research and extension through different regional and national technical working group meeting for exchange of technology and issues. However, the meeting seems like formalities with less availability of demand-driven technology from research organizations and a lack of motivation (to transfer technology) from extension workers. Ineffective technology transfer is due to insufficient research funding, inadequate investment in researcher and extension worker's capacity building, absence of performance-based rewards and punishment, and ineffective monitoring and evaluation. Different policies of Nepal have focused on strengthening research and extension linkages, however there is lack of innovation and commitment from the leaders to strengthen the functional linkage. For federal context similar kinds of technical working group meetings have been proposed in village level, provincial and national level in the participation of the related stakeholders to find out the researchable problems and to disseminate the technology generated from

research to the farmers. Nonetheless, there is a need for strong commitment and priority for agriculture from each government.

Status of Human Resources and Budget Allocation in Agricultural Extension Services

The government of Nepal has launched different program in extending the technology to the farmers, however the human resources working in grass root level for extension or technology transfer are scarce. The federal government doesn't have direct mandate of agriculture extension but national level programs and projects such as PMAMP, FANSEP, REED and ASDP are running their program that constitute agriculture extension. After federalization, approved permanent position of technical manpower for federal agricultural governance is 2048 (officer and above 988 and non-officer 1060) that fulfills the permanent organizational structure in the federal level. However, to run those national level programs and projects there is still scarcity of stable human resources. In fiscal year 2022/23, PMAMP had 12% human resource vacant (including both permanent and contract staffs) and out of 831 approved positions, 65 % were fulfilled through contract (officer and junior technicians) where most of them were fresh with lack of field experience, later after few years of experience and capacity development, high staff turnover hampers in technology transfer (PMAMP 2023). In addition, the distribution of the human resources is not uniform among districts and provinces with 18% vacancy in Far-western province (PMAMP 2023).

The status of human resources in other tiers of the government is also scarce with low employee adjustment after federalization and low recruitment. The total number of approved technical positions in the provincial governments are 1925. Out of this, 619 officers and 587 non officers are working with 37.4% position vacant. Bagmati province has the highest number of the positions fulfilled, whereas Madhesh province has the least (Annex 1). The total number of approved technical positions in the local level are 7071, out of which 5021 are working and majority are on contract basis. The local bodies in the Koshi province are the most fulfilled while Karnali is least fulfilled (Annex 2). Although 71% positions are filled, major capacitated human resources deny to work in the local level because of the bureaucratic hurdle, low priority to agriculture sector and lack of other motivational factors (Dahal et al 2020). Thus, it has been challenging to recruit and retain the technical positions which has direct influence on the coverage of the agriculture extension. NSO (2023) reported that the 62% of total households of the country (equivalent to 66, 66,937) are agriculture households and one front line extension worker (technician available at local level) is responsible to oversee 1328 agriculture households. This ratio is 1:806 households when the total number of extension workers available in the country are considered.

The total budget allocated in the agricultural sector in the year 2022/23 was 48.1, 1.8 and 6.1 billion in federal, province and local level respectively (MoALD 2022). Which was about 3.12% (2.6% for federal, 0.09% for province and 0.33% for local level) of the total national budget. This excludes the budget allocated from province and local level from their own sources for agricultural development. The 33.4 billion (69.5%), of the federal budgets was allocated for fertilizer subsidy, and very limited budget has been used for technology transfer. Similarly, less than 7% of the total federal agriculture budget was allocated in agriculture research in the year 2022/23 (Timsina 2023). In province, 20 billion budget was allocated (Annex 3) which also include the share from the federal government. Among provinces, the allocation of budget is highest in the Bagmati province and least in the Koshi province. The low budget allocation does not seem to be a problem with such a low number of the human resources in the agricultural sector governance, however for agricultural transformation, the nation requires to increase the number and capacity of human resources along with budget.

Status of ICT in Nepalese Agriculture

The use of the Information and Communication Technologies (ICT) in agriculture are rising and has transformed the way farming and agricultural activities are carried out. Studies show that ICT in agriculture affect economic growth and productivity of inputs positively (Spielman et al 2021, Nakasone 2014). ICT in

agriculture extension reduce the dissemination cost, provide technology and market information timely for huge mass, can be accessed from remote location and support in informed decision making. Some common ICT tools used in agriculture are telecommunication, radio, television, internet, software technologies, mobile application etc. Advanced technologies such as Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing, RFID technology, computer controlled automated system is emerging.

In recent years, ICT has been the part of the Nepalese agricultural system and is in growing trends. Nepal governments Digital Nepal Framework, 2019 has also emphasized digitalization in agriculture. Technology transfer, real time market information, weather forecasting, advisory services, online marketing, e-commerce, financial services, data management, precision farming are some of its uses in Nepal. The main organization which are promoting the use of ICT in the agricultural sectors are National Agricultural Technology Information Centre, Nepal Agricultural Research Council (NARC); Agricultural Information and Training Centre, MoALD; Department of Hydrology and Meteorology; Provincial Ministry and Directorate; National and Provincial wholesale market, NGOs, private sectors, and local governments. The major contents by these organizations are kisan call centre, radio and television related agricultural programs, weather forecasts, digital seed system, market information system, kisan credit card, E-Library, Websites and Mobile Apps etc. The mass media like radio, newspaper and television are used from the very old times in disseminating the information in agriculture extension. Recently, internet software and mobile applications use are growing. A dozen of mobile apps are available for agriculture extension, however only few are active and updated e.g. Geokrishi, Super Krishak, Smart Krishi etc. The Mobile Apps for agriculture extension are for service purpose which require continuous financial support for content update. The increasing access to mobile phones and internet services among farmers indicates that there lie possibilities of connecting smallholders to the information ecosystem through ICT. However, various factors such as education, infrastructure, technology literacy, cost of tools, socio-economic condition, etc. of farmers are affecting its adoption, which should be considered before forming plans and policies to increase its use. Various subsidies and incentives in ICT facilities for e.g. subsidized farmers data pack for farming related apps, along with technology literacy program can be an excellent idea to increase its adoption and to solve the problem of agriculture expert crisis in rural areas.

Agriculture Extension System (AES) in Selected Agriculture Led Countries

The agricultural extension systems were found diverse across the countries. The selected agriculture led countries have adopted pluralistic extension approach like Nepal, which involves services given by government agencies, research institutions, non-governmental organizations (NGOs) and private sectors to reach a wide range of farmers and address various agricultural issues. All the selected countries have decentralized agricultural extension system to lower level of government. The comparison of key extension approaches among selected countries and its relevancy in Nepal are presented in [Table 3](#). The functioning of agriculture extension and research was found to be varied across the countries. The three different cases from China, South Korea and Israel are discussed considering the operational modality of research and extension system.

Table 3: Comparison of key extension approaches among selected countries and its relevancy in Nepal

Extension approaches/ Models	Countries	Status and prospects in Nepal
Involvement of producer's association	Kenya, Israel, India, Philippines, South Korea, Indonesia, China	Commodity-specific Producer Associations exist in Nepal. Such associations have huge potential in technology transfer and market management.
Subsidy to farmers	India, China, Kenya, Israel, Thailand, Philippines, Indonesia, South Korea	Nepal provides subsidy for seed, fertilizers, irrigation, farm machinery, insurance, credit etc. Need to customize subsidy program (eg. based on farmer's categories, value chain types, pre/post productions, market, locations etc.), better to provide subsidy in services rather than items.
Leader farmers as service providers	India, China, Kenya, Israel, Thailand, Philippines, Indonesia, South Korea	Nepal has been implementing training for leader farmers to scale up technology transfer, it is necessary to institutionalize and recognize them for agriculture extension which helps to address the issues of scarce human resource in local level.
Extension officer as front-line extension workers	Israel, Indonesia, Philippines, South Korea, Thailand, China, India, Kenya	The majority of local governments have extension workers on a contract basis; however, they are not well trained in different cross-cutting agricultural issues. They must have at least one agriculture and one veterinary officer in municipal level, junior technicians in ward level. The subject matter specialists from province level should backboned municipal extension worker along with their capacity development. They must also focus on technology demonstration and dissemination.
Use of ICTs	Israel, Indonesia, Philippines, South Korea, Thailand, China, India, Kenya	Increasing use of ICT in agriculture extension mainly via, call center, SMS, mobile apps and agro advisory services. Government, NGOs/INGOs and private sectors have been supporting to use ICTs in agriculture. Capacity development of agriculture expert in delivery point and digital literacy in end-users is required to maximize effective use.
Use of Community based organizations	Israel, India, Indonesia, Thailand, China, Kenya, Philippines, South Korea	Few farmers' cooperatives/groups act as an important intermediary between farmers, traders and agriculture extension services by managing inputs like seed and fertilizer, and market management. Their involvement in agricultural extension, community-based seed production, value addition and market management need to be strengthened.
Research & Extension (R& E) as single entity	South Korea, Israel	There is separate R & E with weak functional coordination. Mandatory legal linkage mechanisms to facilitate joint program planning and monitoring is required and prioritizing investment in research for technology generation and involvement of extension from the beginning of technology verification.
Involvement of private sector	Israel, Indonesia, Philippines, Thailand, China, India, Kenya	There is private sector involvement in inputs supply and agri-business e. g. agro-vets. Emerging investment areas are on-farm advisory services, technology development, post-harvest management, financial services, e-commerce etc.
Commodity based agriculture extension services	Kenya, Israel, Philippines, South Korea	Commodity based services is not practiced yet in Nepal. Introducing this approach focusing in trade (import substitution and export promotion commodity) is the best.

Source: NILERD 2015, Singh 2006, Davis et.al 2012, Soam et al 2023, Swanson and Mathur 2003, Kingiri and Nderitu 2014, GFRAS 2011, Muyanga and Jayne 2006, MEAS 2011, Kiteme 2009, GoK 2005, Michelson et al 2013, Kaegi 2015, Hu 2012, Hu

et al 2009, MOA 2011, Muddassir and Naseer 2017, Lin et al 2022, Harrell 2023, Uathaveekul 2011, FAO 2023, Dung 2020, Robert 2000, Falvey 2000, Thuvachote 2006, Rusliyadi et al 2018, APO 2006, Rafani 2023, Alston 2000 NCAE 2013, Hayami and Kikuchi 2000, Sharma 2006, Hayami and Kikuchi 2000, Tapang-Lopez 2022, Hayami and Kikuchi 2000, Abraham et al 2019, GFRAS, 2017, Lehmann 2019, Said et al 2019, Ko et al 2014, Qamar, 2014, Yong-sup 2023, and experts consultation.

Case 1: Agriculture extension system of China (R & E separately)

Agriculture extension system in China is mainly funded by public (Lin et al 2022) and provided through five different levels (national, provincial, prefectural, county and township) and six administrative agencies (2016). Under provincial level, Department of Agriculture and Agriculture Leadership Working Group provide program support and advisory services to the farmers. Within county and municipal governments, Bureau of Agriculture is involved with agricultural extension. In township level, Local Agricultural Extension Offices under Cheng et al administration of the municipal Bureau of Agriculture is responsible for extension services (Cheng et al 2016). Study found that extension agent spent 9.2 % more time on agricultural extension services that were administered by county than those managed by township-level (Cai et al 2020). Under administration of township level extension agents (non-professional) required to spend more time on administrative affairs and had less capacity to provide agricultural extension services to local farmers (Hu et al 2009).

The Chinese government initiated targeted reforms to assess the farmer's extension service needs. They also introduced subsidy and demonstration programs in order to promote the adoption of modern agricultural technology and to offer assistance to the farming community (MoA 2015, Wang et al 2017, Wan and Cai 2021, Lv et al 2021). In addition to the public extension system, NGOs, private companies, farmers-based associations/cooperatives/societies, model farmers, village leaders and retailers have been providing services to millions of farm households. Farmers perceived extension services as a significant source of agricultural information which played crucial role in farmer's decision making for the technology adoption (Anderson and Feder 2003, Qiao et al 2017). China's agricultural extension system has made significant progress in recent times despite facing challenges like market competition and funding shortages. A study has found higher influence of private companies in technology dissemination to sell their product especially in seed, fertilizer, machinery, pesticides (Liu et al 2023) along with high use of ICT in technology dissemination (Li et al 2022).

Research in China is decentralized, largely funded by public and major funding are on competitive basis. The core of China's public agricultural research system is formed by an array of agricultural research agencies at the national, provincial, and prefectural levels (Chen and Zhang 2011). Chinese Academy of Agricultural Sciences (CAAS) is a national comprehensive agricultural research institution with 34 affiliated research institutes and cover a broad range of topics that have been categorized in 11 major discipline clusters, consisting of 58 discipline fields and 283 key directions. National level research focus on basic research and technologies, provincial institutes concentrate on applied research tailored to their provincial agro ecological boundaries. Prefectures agricultural research institutes focus on adaptive research of local relevance. Provincial and Prefectures research institutes integrate research with extension through outreach in their projects. Online platform, agriculture science and technology park, agro-technology demonstration, training for extension agents, scientific publications, media, etc. helps to link between research and extension. Private agricultural research is minimal, although private agricultural research and development initiatives have begun to emerge in recent years (Babu et al 2015). The sheer size and highly decentralized structure of agriculture research and extension systems limits its ability to respond to the changing needs of farmers and consumers. Duplication of research activities and funding are also the major challenges.

Case 2: Agriculture extension system of South Korea (R & E Jointly)

In South Korea, the Agriculture Extension System is public funded (Ko et al 2014). The Ministry of Agriculture, Food and Rural Affairs (MAFRA) has overall responsibility for public agricultural extension services but this responsibility has been carried out by the Rural Development Administration (RDA), working as an autonomous institution within the Ministry (Qamar, 2014). RDA is a key government agency responsible for agricultural research, development, and extension. The Korean agricultural research and extension system is unique, it has successfully combined the technology development with technology dissemination functions within one organization. The main duties of the RDA are research and development for the improvement of agricultural technology; transferring knowledge and technology; and training farmers, rural youth, student, teachers, local leaders as well as extension workers in local level (RDA 2004).

Public agriculture extension in Korea is based on the network among RDA, provincial agri. research & extension services and city/county extension centers. Organizational structure of RDA at central level consists of the extension service bureau, research policy bureau, planning and coordination bureau and technology cooperation bureau. Under extension service bureau, extension planning division, research and development extension division, rural resources division, disaster management division, food crop industry technology team, and youth farmer fostering team has been working for the technology transfer in close coordination with technology transfer divisions affiliated under four national institutes i.e national institute of agricultural sciences, national institute of crop science, national institute of horticultural and herbal science, and national institute of animal science. Similarly, rural human resource development center under RDA has been playing crucial through training and capacity building for agricultural extension services in Korea. As of May 2022, 1205 scientists, 105 extension specialist and 593 technicians including admin officers were working under RDA (Yong-sup 2023).

Initially, RDA was solely given the authority by law to manage and approve for other organization's business to the agricultural extension, which helps to coordinate all extension-related projects (Ko et al 2014). After 1997 when the devolution was implemented, extension services are also provided by the provincial agricultural research and extension services (PRDAs) offices, city/county extension centers, and farmers' counseling offices, which are operated by the city/county extension centers' staff in collaboration with farmers' associations (Qamar, 2014). The provincial and city/county extension offices belong to local government ((Yong-sup 2023). At provincial level, there are 9 PRDAs and 42 region specific crop research institute that has been involving for conducting practical and applied research, providing training and extension services through subject matter specialists. PRDAs are linked with lower levels of organizations: agricultural extension office (district) and branch offices of agricultural extension office (township) are hierarchically linked to the central RDA (O'Shaughnessy et al., 2021, Ko et al 2014). At city/county level, 156 agricultural extension centers (AEC) have been functioning. Under this, 669 farmer counselling offices has been providing services to the end users. AEC has strong networking with different extension clients such as 4-H members (48) comprising student and young farmers, rural women leaders' federation (77), farmers successors association (130), farmers group by commodity (121), rural leaders association (86) etc (Yong-sup 2023) to provide services to producers, consumers, farmers associations, farm family, universities and industries. There were 850 scientists and 4390 extension officers at local government (Yong-sup 2023). Ko et al (2014) argued that the effectiveness of research and extension functions was higher when the extension workers at local level were independent of the local government's administrative system.

Recently South Korea has been implementing extension program comprising of food crops production (rice, soybean, corn, etc.), cash crops production (vegetables, flowers, fruits, etc.), livestock production (animal husbandry and livestock sanitation etc), organic farming, education and training program, young farmer program, farmers organization program, rural home improvement, value chain (the 6th industrialization), rural resources development (rural tourism, care farming), farm machinery rental service and repair training program etc. (Yong-sup 2023). Qamar (2014) reported that the very limited participation of non-public organizations in agricultural extension in South Korea. Similarly, he added, universities and colleges are not in the forefront for providing agricultural extension services. But they offer academic programs in various agricultural and rural disciplines including agricultural extension, offer consulting services, conduct research studies, and organize short training courses in technical subject-matter.

The strong linkage mechanism between agriculture research and extension in South Korea has ensured through joint problem diagnosis, priority setting, planning, review meeting and monitoring. They adopted formal collaboration in trials, survey and dissemination activities. Similarly, they also participate jointly on release of recommendations. They have formal guidelines for allocating time for collaborative procedures and staff rotation and secondment mechanism. Since 2010 they have shifted their priority of agriculture extension services to agriculture knowledge services (eg. from transfer of technology to sharing of knowledge, farmers cantered to farmers plus consumer centered, primary industry cantered to secondary and tertiary industry centered, face to face contact to self-directed learning using ICT etc.) (Yong-sup 2023). With regards to the ICT, the application of ICT technology, weather and climate information is more accessible to farmers. Most farmers get their weather and climate information (daily temperature, precipitation, humidity, day light hour, and so on) from a smart mobile phone (44%) or an internet device (22.5%) (Kim et al 2015). RDA has been running its real time Agricultural Weather Information Service. It also runs National Crop Pest Management System for pest forecast, expert consultation and required support along with disaster related information system. Smart farm technology has been promoted in both open and close cultivation system for

sustainable agriculture and optimization of resources. The smart farm agriculture extension model in South Korea is a recent development that aims to modernize and improve the efficiency of the country's agriculture sector through the use of advanced technologies such as IoT (Internet of Things), precision agriculture, and automation. This helps to increase efficiency and reduce labor costs. The government of South Korea is also playing an important role in the development of the smart farm model by providing financial assistance and support for the development of new technologies, as well as training and education programs for farmers (O'Shaughnessy et al 2021). The smart farm agriculture extension model of South Korea is an innovative approach to modernize the traditional agriculture system. Overall, the success factor of agricultural development in Korea is driven by continuous and strong supports by government, developing core competencies of farmers, strengthening strong linkages between research and extension, and investing more on research and extension (Yong-sup 2023).

Case 3: Agriculture extension system of Israel (R & E Partially)

The agricultural extension in Israel acts as a bridge between research and growers (Lehmann 2019), with a focus on improving agricultural practices and increasing profitability for the agricultural sector (MARD 2021). The extension system work in collaboration with farmers' associations, commodity production, marketing boards, and research institutions to achieve a high level of agricultural productivity and efficiency (Lehmann 2019). The agricultural R&D is led by Agricultural Research Organization (ARO), also known as the Volcani Institute, responsible for 75% of the agricultural research (GFRAS 2017). The ARO and Extension Service (a government advisory unit also called "SHAHAM") work together under the Ministry of Agriculture and Rural Development for agriculture development. These two organizations locate close to each other and extension workers were required to spend 30 percent of their time on research (Abraham et al 2019). The Agricultural Extension Service provides high-quality advisory services with focus on applicable know-how to the farmers.

Ten research and development stations were also established to serve the needs of the agricultural regions. The management board of both research and extension includes representative from research organization, extension service, farmers and other stakeholders. The agricultural extension model in Israel has been widely recognized as one of the most successful and innovative in the world for its success in increasing agricultural productivity, improving water management and promoting sustainable agriculture (Shakya 2022). The important aspect of the Israel's extension model is the close collaboration between farmers, government agencies, and research institutions. This includes regular meetings and workshops where farmers can learn about new technologies and research findings, as well as receive training on how to implement them on their farms. The government of Israel also provides financial assistance and subsidies to farmers to help them adopt new technologies and improve their operations. This includes grants for research and development, as well as subsidies for purchase of new equipment.

According to Abraham et al (2019), Israel's extension service has been successful because the extension workers were specialized and organized by a crop or a crop family, they were provided with the tools they needed to be out in the field with farmers. An extension worker would meet each farmer every other day to closely inspect the progress in the growth of the crops. The extension system also use ICT to transfer technology, information management, production chain efficiencies, and greater collaboration within the agricultural sector (Gelb et al 2009). Research on advanced technologies, development of crop varieties suited to the country's arid climate and improved farming methods such as precision agriculture (irrigation and nutrient management) are highly emphasized. The country has implemented various water-saving technologies and water recycling systems. Further, the government program and policies to spend up to 30% of the budget on water, infrastructure, and agriculture after prioritizing crop products to invest in demonstrate its serious commitment in agriculture development (Abraham et al 2019).

Further, a common message of farmer collaboration was provided to farmers that they were not competing against their neighbors, rather they were competing together with their neighbors Spain and Turkey to access the market in France and so on. This promoted a sense of collaboration among farmers. Effective government, sound farmer organizations, farmer centric, multidisciplinary, market-oriented and innovative approach to solve farmer and private sector problems are the pillars of Israel's successful agriculture development.

DISCUSSIONS

Extension services are expected to play an important role in enhancing agricultural performance. Over the past years various extension approaches in Nepal were experimented such as Training and Visit system, the

Tuki System, the Block Production Program approach, the Farmer Group approach, the Pocket Package Program approach, the Projectization approach, Farmer Field School approach, Public Private Partnership approach are among the tried system. The contribution of donor-funded projects, university systems, INGOs/NGOs, agro-vets, private seed and feed companies in extension of agricultural technology cannot be denied. Despite several efforts made by the top-down extension system, there were various bottlenecks encountered and it was criticized as being less effective. While the need for an improved extension system in Nepal was well recognized, the political reform in 2015 has caused major changes in its governance structure. The unplanned and *ad hoc* federalization in agriculture sector governance in 2018 led to difficulties in human resource management, institution set up, coordination, national policy implementation, and accountability which contributed to overall weak performance in agriculture sector. Five years has already passed after agriculture sector governance reform but improvement in agriculture extension system is barely observed.

There are a few major areas that need to be discussed before recommending a new reform in agriculture extension system in Nepal. First, as agricultural extension delivery in Nepal has been delivered by three levels of government and become more pluralistic, a greater level of coordination is required. The major issues that arose in the discussion of pluralistic extension systems were coordinating the system, avoiding duplications, ensuring adequate coverage of rural populations, assuring quality, and building capacity of service providers (Alex et al 2004). In most federal systems, two tier governments such as municipalities (local levels) are integrated into the state governments. Only seven countries have three-tiers structure, out of 25 federalized countries (FoF 2022). Nepal has also adopted a three-tier federal structure with exclusive legislative powers granted to each government (Laws 2017, Kyle and Resnick 2016). However, Laws (2022) reported that the complex relationships among three levels of government may hinder effectiveness, efficiency, failure of policy and an erosion of good governance, rather a well capacitated (both financial and human resource) local level has possibility of getting improved outcomes. Timsina (2023) reported that local government in Nepal has allocated less than two percent of total budget in agriculture sector, and about 30% positions are vacant. Growth in the agricultural sector is seen as a means of reducing poverty through increased incomes of smallholders, who comprise about 63 percent of farming households (having <0.5 ha) in Nepal (NSO, 2023). These community required effective service delivery at local level which demands capacitated local government. The ability to reach the massive population has been limited due to few institutional setups and human resources at district and local level (Babu and Sah 2019).

In many developing nations, extension programs are struggling with the issues like insufficient local funding, reliance on erratic and tardy central government grants, trouble hiring and retaining staff locally, and corruption (Bashaasha et al 2011). The effectiveness of agricultural research and extension functions is varied by the extension services administered by different administrative system. In South Korea, when the extension workers at local level were independent of the local government's administrative system, the effectiveness of research and extension functions was higher (Ko et al 2014). Extension agent spent 9.2 % more time on agricultural extension services that were administered by county than those managed by township-level in China (Cai et al 2020). Similarly, under administration of township level extension agents (non-professional) required to spend more time on administrative affairs and had less capacity to provide agricultural extension services to local farmers (Hu et al 2009). The problems and challenges has been observed with a new proposed system of agriculture extension of having insufficient face-to-face interaction between extension workers and farmers; insufficient funds for operational purposes; insufficient personnel and technical qualifications of grassroots extension workers; dilution of impact by thin coverage; failing to meet the needs of the specialized client for e.g. the commercialization of agriculture's demand for location and commodity specific extension services; the high cost and limited impact of extension programs; coordination and accountability (Dhital 2017, Babu and Sah 2019). Technology centric, pluralistic, participatory and demand-driven approaches employing multiple pathways and administrative hierarchies is essential.

There is weak functional coordination between institutions at various levels of government working for research and extension (Paudel and Wagle 2019, Timsina et al 2018). To overcome this, vertical and horizontal functional linkages mechanism should be adopted among the stakeholders from stages of problem identification via technology verification to technology dissemination and upscaling (Timsina et al 2018, Gauchan et al 2022). Under federalized system, the agriculture extension service is decentralized and pluralistic with improved participation and control by local communities compared to unitary government system (Tamang et al 2020). However, the example from different countries shows that effective coordination and collaboration among the central and provincial and/or local government is the greatest problem (McNamara et al 2011, Simpson et al 2012). In Nepal, the delivery of integrated and specialized agriculture extension services is less-effective due to the lack of coordination among the three tiers of government. After the formation of provincial and local governments, poor governance, institutional arrangements and human resources management has been a critical issue. The major problems faced by the Agriculture Knowledge Centre (AKC) is the lack of proper mandate and coordination with the local government units i.e. municipalities (Dahal et al 2020). There is deteriorated service delivery in the agricultural sector after federalization in Nepal primarily due to poor coordination and linkage pertaining to poor agriculture extension services (Jaisi et al 2018, Thapa et al 2019). In Nepal, three level of governance in agriculture has been creating confusion in program implementation due to weak vertical coordination among them. Therefore, two level of agriculture governance for effective coordination and improved outcomes are necessary.

Different countries have variations in extension staffs and farmers household ratio. The gaps between the number of extension staffs and farmers were wider in Kenya (Kingiri and Nderitu 2014, MEAS 2011, Kiteme 2009, GoK 2005). The Government of Kenya launched the Agriculture Sector Transformation and Growth Strategy (2019-2029) to ensure the country to attains a ratio of one extension personnel against 600 famers by the year 2029. In China, one extension staff per 283 farm households is reported by Hu (2012). Similarly, in Bangladesh, one field-level extension worker is responsible for 900-2000 farm families (Haq, 2013). Based on NSO (2023) the ratio of front-line extension worker (technician available at local level) to agriculture household is 1328 in Nepal. This shows the demand to increase manpower to reduce this ratio. In this context, well-experienced local farmers can be trained to develop local service providers (like "female health service volunteer"). This kind of program could enhance farmers' capacity and create value of farmers in society.

Among the different agriculture extension models adopted in different countries, use of farmers producers' organization's (FPOs) could be an innovative idea to involve them in agriculture inputs supply and market management in Nepal. Kujur et al (2019) reported that farmers involved in FPOs, increase in income, savings and employment opportunities with better economic status in community compared to non-members. Different countries have been adopting different kind of research and extension models and operational modalities. Countries such as Thailand, China, India, Indonesia, Philippines, Kenya etc have been operating research separately from the extension (Rafani 2023, Soam et al 2023, Swanson and Mathur 2003, Tapang-Lopez 2022, Kruijssen et al 2019, Robert 2000, Falvey 2000, Kingiri and Nderitu 2014). Other countries like Israel and Malaysia have adopted hybrid model. In Israel, extension workers are required to spend 30 percent of their time on research (Abraham et al 2019), whereas in Malaysia, researchers need to spend their 30% time in extension (Qamar 2013). One of the special characteristics of the Korean AES system is that the AES implementation organization, the RDA, executes both R&D and AES functions (O'Shaughnessy et al 2021, Ko et al 2014). Implementation of both functions led the RDA to diffusing research results and innovative technologies easily and quickly through training of extension workers and growers (Choi 1995). Extension department personnel were agents, whom the government systematically trained to produce specialized experts, and they delivered effectively the new technologies created and developed in R&D departments of central and provincial RDA systems to reach fields and farmers (RDA 2004). Rural human resource development center under RDA has been playing crucial through training and capacity building for agricultural extension services in Korea (Yong-sup 2023).

Different countries have been using ICT for the extension of agricultural technologies. The application of ICT technology in South Korea found to be effective. Through the use of ICT, they have been providing services for pest forecast mapping system, export consulting and supporting system, disaster related information system. Similarly, the smart farm technology applied varies based on the crop varieties or farm size, the remote-control function of temperature humidity, and nutrients solution, irrigation, pest occurrence detection, and security systems. The smart farm website is also in operation in Korea. The use of ICT to increase agent monitoring as a way to boost motivation and performance is a promising avenue for research, including evaluating the effectiveness of increased monitoring. Examples include the use of video to allow extension workers to document effort (Duflo et al 2012) and the use of geo location to determine whether extension workers visited certain locations (Dal Bó et al 2021). Ghimire et al (2021) recommended for adopting different new approaches, methods and tools in agriculture extension in Nepal and urged that the frontline extension workers should be competent to handle the ICT for effective service delivery. Similarly, it is also important to redesign the extension materials and approaches using behavior theories to increase adoption of technologies at farm level that is generated by research stations in Nepal (Timsina et al 2023, Ghimire et al 2021). The quality extension services from the professional experts are one of the key demand area of people with local government. The ICT can be effective tool to link local people with experts based on their demand as most of the local authorities are under capacity in terms of number and technical expertise.

The current system for delivering agriculture extension services in Nepal has a number of difficulties, including institutional instability, conflicting institutions' claims to authority and control, a lack of human resources, particularly at the local level, and a fluid policy framework. Delivering agriculture services has been divided up among local agriculture units in municipalities and rural municipalities that do not adhere to the Agricultural Development Strategy (ADS) vision since DADOs and DLSOs were abolished. ADS (2015-2035) in Nepal has proposed Community Agricultural Extension Service Centre (CAESC) under Decentralized Science, Technology, and Education Flagship program (DESTEP) for the effective dissemination of the extension services with the involvement of the research, extension and other stakeholders. CAESC is intended to be operated by a board representing local communities, cooperatives, farmer organizations, and agro-enterprises for enhanced agricultural extension services. However, the proposed CAESC is not operationalized except for piloting in few districts (Dahal et al 2020). CAESC needs to be established in all local entities, with complete ownership and through a public-private partnership approach (GSRDC, 2018). For effective extension service delivery, CAESC must be formed at all ward level and make functional under the full ownership of local government with technical backstopping from the related stakeholders.

CONCLUSION

Various agriculture extension approaches and methods have been implemented in Nepal, federalization has demanded an innovative and demand driven extension approaches to address the emerging issues. There is no single approach that could serve a complete solution to the delivery of extension services. A combination of various extension approaches and methods should be integrated as per the specific needs. The following could be some suitable agriculture extension services that could be adopted by Nepal in different contexts:

- Adoption of a pluralistic approach is still important in Nepal involving various stakeholders. The local government should take the responsibility for coordination, technical supervision, support, and quality control in the pluralistic service delivery system by pooling all available resources through reducing unhealthy competition, avoiding redundancy of services, and compensates for low agriculture budgets in the local government.

- Use of well-experienced farmers as local service providers (LSP) in agriculture extension like in India, China, Kenya, Israel, Thailand, Philippines, Indonesia, South Korea can be a great option to some extent for dealing with the issues of under staffing at local level.
- The producer's association has been playing important role for agricultural extension in India, Kenya, South Korea and Israel. Promotion of this approach in Nepal for selected commodities based on activities of producer's association would be good strategy for technology transfer and fund collection for researchable issues.
- The community-based organizations such as cooperatives can be used in agriculture extension like in Israel, India, Indonesia, Thailand, China, Kenya, Philippines and South Korea. Function can be specialized based on their expertise and locational advantages. Such as seed multiplication program, post-harvest management, information of potential market and collective marketing of agriculture commodity would be important in Nepal.
- The introduction of commodity-based extension program like in Kenya, South Korea, Philippines and Israel is equally important in targeting import substitution and export promotion.
- The involvement of private sectors in agricultural extension services like in Israel, Indonesia, Philippines, Thailand, China, India, Kenya is deemed necessary in Nepal. The potential areas to be worked from private sectors areas are on-farm advisory services, technology development, post-harvest management, inputs supply, mechanization, marketing, financial services, e-commerce etc.
- Ensure proficiency of agriculture extension staffs at local level and their periodic capacity building at different levels through training, linking with experts/subject matter experts using ICT. The Capacity development of agriculture experts in delivery point and digital literacy in end-users is required to maximize effective use of ICT.
- Three level of governance in agriculture has been creating confusion in program implementation due to weak vertical coordination among them. Therefore, two level of agriculture governance for effective coordination and improved outcomes are suggested.

In overall, the implementation of both research and extension functions carried out by single entity like in South Korea and Israel disseminates research results and innovative technologies easily and quickly compared to the countries that have different entities for research and extension. However, irrespective of operational modality of research and extension in different countries, technological advancement and application of ICT has been playing important role for the effectiveness of the agricultural extension system.

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Annex 1. Manpower related information in seven different provinces

Province	Approved position	Currently working		Total
		Officer	Non-officer	
Koshi	253	106	35	141 (44.3)
Madhesh	247	50	61	111 (55.1)
Bagmati	338	111	154	265 (21.6)
Gandaki	243	90	79	169 (30.5)
Lumbini	329	114	103	217 (34.0)
Karnali	240	66	77	143 (40.4)
Sudurpashim	275	82	78	160 (41.8)
Total	1925	619	587	1206 (37.4)

Source: Institutional Survey, 2023; Figure in parentheses indicates percentage of vacant positions

Annex 2. Manpower related information in different 753 municipalities

Province	Total approved			Currently working		
	Officer	Non-officer	Total	Officer	Non-officer	Total
Koshi	279	964	1243	267	798	1065 (14.3)
Madhesh	302	811	1113	191	490	681 (38.8)
Bagmati	280	947	1227	201	721	922 (24.9)
Gandaki	180	676	856	116	535	651 (23.9)
Lumbini	247	806	1053	148	646	794 (24.6)
Karnali	343	418	761	214	223	437 (42.6)
Sudurpakshim	392	426	818	235	236	471 (42.4)
Total	2023	5048	7071	1372	3649	5021 (29.0)

Source: Institutional Survey, 2023; Figure in parentheses indicates percentage of vacant positions

Annex 3. Budget related to Agriculture in seven different provinces in FY 2022/23

Province	Budget from province government (billion Rs)	Budget from federal government (billion Rs)	Total budget (billion Rs)
Koshi	1.85	0.35	2.2
Madhesh	2.53	0.21	2.74
Bagmati	4.18	0.31	4.49
Gandaki	2.12	0.41	2.53
Lumbini	2.26	0.22	2.48
Karnali	2.8	0.39	2.41
Sudurpakshim	2.89	0.21	3.1
Total	18.2	1.8	20

Source: Institutional Survey, 2023