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A practice of agro-met advisory service in Nepal

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ABSTRACT

Agriculture is highly dependable on the weather. Nepalese agriculture is being affected by the various weather events as well as the climate change. In this context, agro-met advisory services help farmers to optimize their production through timely and judicious resources management based on the weather information and reduce the losses caused by vulnerable weather. The agro-met advisory generation in Nepal is a very appreciable approach from the Government of Nepal. The information and coverage of domain have been increased as bulletin preparation moves forwards. However, there are few factors to hinder its effectiveness. The complex topography of Nepal with little infrastructure and workforce for providing the higher resolution weather forecast is the foremost. In addition, Nepal lacks information on the functional relationship between various components of the Nepalese agriculture and weather. Furthermore, the change in the structure of the agriculture extension system in the federal policy, the dissemination of the information is challenging. Being optimistic, the lessons from the current practices in conjunction with the improvement made on every factor of the hindrances, the agro-met advisories could be a boon for the Nepalese farmers in the near future.

Key Words: *Weather, Crops, Fisheries, Livestock and Bulletin*

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I. Introduction

In Nepal, agriculture being dominant economy, it is the primary source of livelihood for more than 65% percent of the population although only approximately 21 percent of the total land area is cultivable (AICC 2015). The modernization and significant achievements in Nepalese agriculture sector is expected to feed the ever-increasing population. However, the sustainability is always challenging to keep

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production factors intact and to make the system profitable with modernization in agriculture sector (Rathore 2013). Weather, as one of the major determinants of the agriculture productivity, its information becomes one of the critical components in weather-sensitive decision-making system for organizing agricultural activities (Arunkumar et al. 2015) optimizing farmers resources and reducing weather-related hazards in agriculture (Jagadeesha et al. 2010). Being a sector that employs a large proportion of the workforce, weather-impacts on Nepalese agriculture sector can affect the overall economic growth and wellbeing of the Nepalese farmers.

The climate change in Nepal has already playing the significant role in the agriculture productivity and Nepalese economy (Chalise et al. 2017). Still, about 47% cultivable area is under rain fed condition (MoAD 2016) which brings fluctuation on the agriculture production. Such fluctuations could also be attributed to variations in temperature, rainfall as well as relative humidity. Weather forecast supports to reduce risks and losses in agriculture production system, increase crop and water use efficiency and improves the overall agriculture production (Cabrera et al. 2007; Hansen et al. 2011). The main basis to minimize the losses in agriculture production through optimum weather forecasts is by selecting the appropriate commodity and undertaking some management practices suitable to the anticipated weather conditions (Kenkel and Norris, 1995). Therefore, the coupling of the meteorology with agricultural information, as an agro-met advisory, bridges a gap between beneficiaries (farmers and other stakeholders) and technology producers (meteorologists and agriculturists) (Zuma-Netshiukhwi and Stigter, 2016).

Agro-met advisory services are means of linking the agriculture and weather information. It helps for efficient management of farm inputs, intercultural activities as well as the natural resources. The ultimate goal for agro-met advisory is to maximize the farm productivity and resource use efficiency by exploring positive benefits and reducing the negative impacts of upcoming weather events. Agro-met advisory service is being adopted in different parts of the world with various success stories (Jagadeesha 2010; Arunkumar et al. 2015). However, the country with lower agriculture production level and potential risk of food insecurity realize the merits of using agro-advisories most (Weiss et al. 2000). Therefore, the agro-met advisory services could be best utilize in the country like Nepal which is hard hitted by the consequences of climate change with decrease in crop production (CBS 2017). The weather variability on the various form including unpredictable rainfall patterns and increased weather extremes like heavy rainfall, drought, flood, etc. underlines the significance of the agro-advisories. Moreover, the changes on the weather parameters within the short run will also help the farmers to establish the relationships of weather parameters with the crop and other farm activities to lessen the potential negative effect of the weather.

In 2014, the government of Nepal has started the project “Pilot Project for Climate Resilience (PPCR)-Building Resilience to Climate-Related Hazards (BRCH)” within the framework Strategic Program for Climate Resilience (SPCR). Considering weather vulnerability, climate change and their impact on the agriculture sector, Ministry of Agriculture and Livestock Development (former Ministry of Agriculture and Development) has taken the initiative in technical support of Department of Hydrology and Meteorology (DHM) and Nepal Agricultural Research Council (NARC) under Component D (Creation of an Agriculture Management Information System) of PPCR-BRCH project to prepare the agro-met advisory bulletin for the farmers of Nepal. World Bank is a donor agency for PPCR-BRCH project. Moreover, the Food and Agriculture Organization of the United Nations (FAO) have help to scale up the agro-met advisory services in their project sites since 2018 A. D. under the project “Reducing Vulnerability and Increasing Adaptive Capacity to Respond to Impacts of Climate Change and Variability for Sustainable Livelihoods in Agriculture Sector in Nepal (GCP/NEP/070/LDF”.

This paper highlights the mechanism of agro-met advisory preparation, its coverage, and future perspectives in Nepal. The information will be helpful for various stakeholders who directly and indirectly want to deliver better services to farmers and agriculture-related entrepreneurs.

II. Review and Discussion

A. History of agro-met advisory in Nepal and its coverage

Nepal Development Research Institute (NDRI) and CCAFS has, at first, started program to disseminate the weather based agro-advisories in Rupandehi districts of Nepal in coordination with Department of

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Hydrology and Meteorology (DHM), former Department of Agriculture (DOA), Nepal Agricultural Research Council (NARC). However, only the past week weather information on the temperature and precipitation were used for generating the agro-advisories (CCAFS 2014). The first official attempt of weather forecast based agro-met advisories was initiated by NARC on 10th July 2015 in collaboration with Department of Hydrology and Meteorology and former Ministry of Agriculture and Development (MoAD). The first bulletin was prepared for the Banke district of Western Tera. The coverage of agro-met advisory expanded with addition of two Terai region districts; Rupendehi and Bara on April 2016. The hills (Surkhet) and mountains (Jumla) districts were added to list on September 2016. Three more districts viz. Morang, Dhankuta and Kailali were added on December 2016. The coverage was further extended with addition of Kaski, Dang and Doti districts on January 2017. Dolakha, Kavrepalanchok, Chitwan and Palpa districts were included on March 2017. In addition, Saptari, Darchula and Dhading districts were covered on April 2017. The bulletin further enclossed Sankhuwasabha, Jhapa, Sunsari, Siraha, Mahottari, Mustang and Rukum districts onJune 2017. Currently, Rukum district has been partitioned to east and west Rukum as two districts. These districts were representation all possible ecological domains such as hills, mountains and terai regions. These districts are selected based on five different indicators; agriculture production, climate vulnerability index (Food and drought) as defined by NAPA 2010 and information sources (households for radio and mobile phone users) (MoAD 2018). Further, on March 2018, the NARC started to provide the agro-advisory for Arghakhanchi, Kapilbastu and Udaypur district from FAO funded project. At present, the agro-advisory is being prepared for the 29 districts of the country.

B. Weather

As a part of activities of component D [Creation of Agriculture Management Information System (AMIS)] of PPCR-BRCH Project, NARC is collaborating with Ministry of Agriculture and Livestock Development, the Food and Agriculture Organization for United Nations and DHM to help in agro-met services to the farmers of Nepal in 29 pilot districts. DHM provides two types of information for Weekly agro-met Advisory Bulletin: A) Weekly weather outlook, B) weather information of the past two weeks. In the context of unavailability of a numerical weather prediction system for seven-day forecast and real-time weather data, DHM is using existing tools to provide above mentioned two weather information.

Weather outlook

Meteorological forecasting division of DHM has the capacity of providing twenty-four hours and three-day public forecasts. In addition, as a pilot activity, DHM is providing seven-day weather outlook for agro-met advisory bulletin using forecaster's judgment on four levels of weather information. First weather information is surface analysis used for twenty-four hours forecast. Second is a visible and Infra-Red satellite map, third are three-day numerical weather prediction models, and fourth is extended forecast from international public/private agencies and various national meteorological agencies. To make the efficient weather outlook, first the districts are divided into clusters based on climatic classification (Figure 01). The schematic diagram of four categories of weather information used for seven-day weather outlook for each cluster is shown in Figure 02.

Surface analysis

The first set of weather information to start weekly weather outlook is a surface analysis based on data from sixteen synoptic stations in Nepal and additional stations from neighboring countries (India, Pakistan, Bangladesh, and China, etc.). This surface analysis map with various meteorological parameters is used to predict twenty-four hours public weather forecast

Satellite pictures

Satellite products are the second set of weather information that Meteorological Forecasting Division (MFD) uses to aid the surface analysis in predicting future weather. MFD typically uses cloud pictures to track storm movement and development and understand the type of the cloud to predict precipitation. Satellite pictures from Himawari 8 visible and IR channels and FY2E visible channel.

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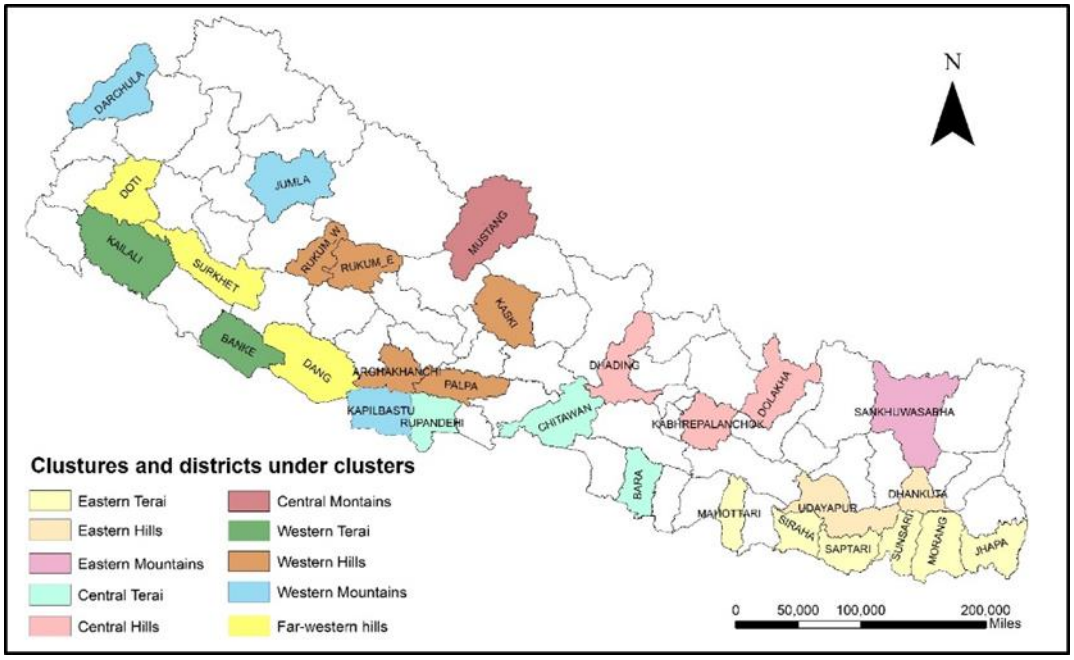

Figure 01. Cluster based on climatic classification and coverage of agro-met advisory services.

Numerical weather production (NWP)

MFD/DHM uses Weather Research and Forecasting - Environmental Modelling System (WRF-EMS) for three-day weather forecasting. The model output is the nested at a horizontal resolution of 12 and 4 km in outer and inner domain respectively. The model is run four times a day (at 00, 06, 12 and 18 UTC) using GFS global model data for the initial conditions. Currently, MFD/DHM made available selected variables such as hourly precipitation, Temperature, Wind, Wind Gust from 4km resolution run for the period + 12 hr. to +84 hr. This is updated every six hours. Since NWP is work in progress at present with shortcomings and gaps in verifications and validations, MFD/DHM does not rely only on the model output but uses it as one of the tools, in addition to surface analysis and satellite pictures, to make weekly weather outlook.

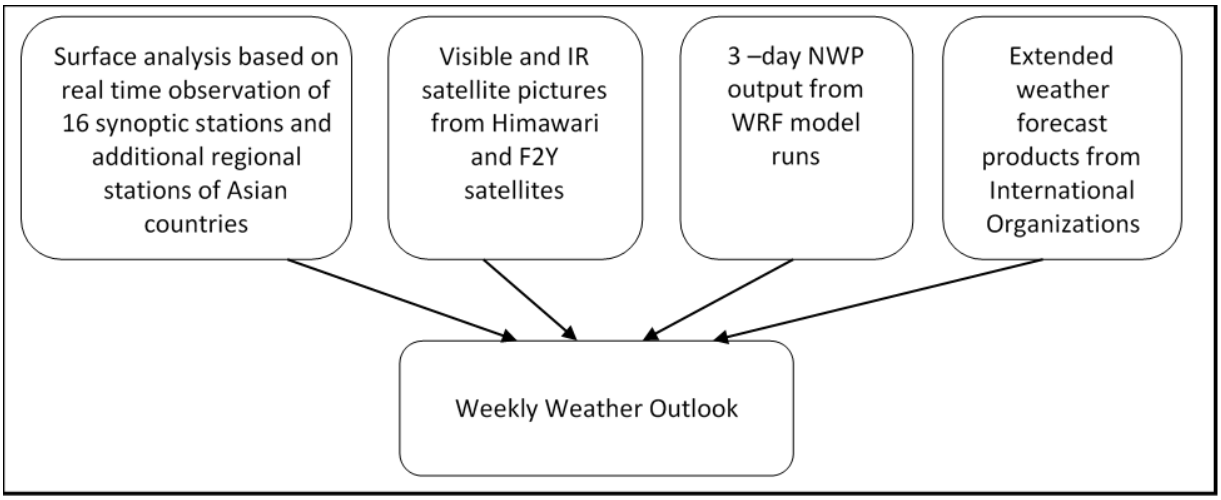

Figure 02. Four categories of weather information used for seven-day weather outlook.

International extended weather forecast

In the context of limited capacity to produce seven-day weather forecast, MFD/DHM uses a number extended forecast products from various forecast providers outside the country. These forecast products are used as additional tools first to compare and understand the surface analysis maps and then to make seven-day weather outlook. Two types of forecast products are used from these extended forecast providers. The first application is the forecast of a wind system and pressure patterns. This is used to understand how the weather is moving and will move in the next seven days. The second

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application is forecasted variables such a temperature, precipitation, cloud cover, and wind. The outlook is subjective and depends on the forecaster's judgment. These variables are used to make seven-day outlook of precipitation, temperature, and cloud cover for 29 districts in ten climatic clusters. The outlook does not provide quantitative information on weather variables but provides the qualitative forecast. Figure 02 explains the qualitative information used in weekly weather outlook.

Weekly weather observation

Agro-met section of DHM provides weekly weather observation to prepare Agro-advisory bulletin (AAB) for 29 districts. DHM uses one station in each district. While one station may represent weather conditions of the entire district in Terai flatlands, one station data is not enough to represent the district in the Hilly and mountain districts. However, DHM use the environment and altitude of the station to extrapolate the information during the preparation of agro advisory. DHM provides rainfall, temperature, relative humidity and wind data of these districts.

C. Crop and livestock status

Crop and livestock status are the primary inputs for generating agro-met advisory bulletin. The status is being collected from all twenty nine districts. The extension offices under Ministry of Agriculture and Livestock Development and researchers from NARC cost centers are the major stakeholders to collect past week crop and livestock information from their working areas. The information from the various locations within districts is compiled to make the district level status. For the districts under FAO program, the district coordinator compiles the collected information from their working areas (rural municipality and municipalities of respective districts) to make district level crop and livestock status. The crop status mainly includes a week information on crop type, sowing or planting time, area coverage, stage of the standing crop, pest problems (insect and diseases) along with their symptoms and damage levels, plant nutrition, farmers' practices adopted to solve various observed problems, weather/climate-related hazards as well as other management practices. The crop sector encompasses cereals (rice, wheat, maize, minor crops), legumes (soybean, black gram, chickpea, lentil etc.), oilseed (mustard, rapeseed, groundnut etc), industrial crops(sugarcane, jute), fruits (mango, litchi, pomegranate, mandarin orange, lime, banana, pineapple, apple etc), vegetables (cauliflower, cabbage, brinjal, tomato, potato, chili, pumpkin, okra, bitter gourd, leafy vegetables, leguminous vegetables), nursery management etc.

Similarly, the livestock status includes livestock type, age, problems related to reproduction, diseases, number of infected animals, health status, mortality rate, and farmers practices to minimize the disease impact on the animal health. The major livestock is buffalo, cow, pig, poultry, goat, and sheep. Furthermore, animal nutrition section considers various fodder and forage status on similar information as cereals crops. Fisheries are another sector included in the bulletin. The information on fish farming includes type of the breed, age, diseases, fish pond related problems, fish nutrition and other management practices.

D. Generation of agro-advisory bulletin

Nepal Agricultural Research Council (NARC), an apex body for national agricultural research, is mandated for providing the agro-met advisory. The Agricultural Environment Research Division (AERD) under NARC is taking a lead role. It has formulated a team consisting subject matter specialists from the different background including agronomy, horticulture, soil science, plant pathology, entomology, agriculture extension, fisheries, animal health, pasture and fodder, meteorology and climate change, etc.

At first, the expert team receives weather outlook for the upcoming week from Department of Hydrology and Meteorology and crop and livestock status from respective districts each Thursday through email, a day before agro-met generation. Based on information on weather outlook and crop and livestock status, the expert team meets every Friday at Agricultural Environment Research Division, NARC, Khumaltar, Lalitpur, Nepal to generate the agro-met advisory. Each member of the expert team provides the advisories on their respective sectors considering the status of the crop, livestock and forecasted weather. In the case of public holiday, the agro-advisory is generated on the next working days. Till date, the advisories are only being produced in the Nepali Language to make it farmers friendly.

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E. Examples of key information included on agro-met advisory bulletin

- With decreasing amount of precipitation, rice might experience moisture and nutrient deficiency and results in brown spot. Therefore, farmer need to irrigate field and spray DIATHANE M-45 (Mancozeb) at the rate of two gram per liter of water two to three times at a week interval.
- There is a chance of light to moderate rain in most of the days of the upcoming week, therefore, ensure proper drainage on maize field.
- The Pyrilla insect infestation might be seen on the sugarcane field with increasing temperature and humidity, monitor the field regularly.
- For the upcoming week, the humidity is favorable for the powdery mildew on tomato in mid hills. So, spray suitable fungicides.
- The relative humidity will be low in next week, spray water on the grafted mango following stone or epicotyl grafting method to keep at humidity level 80-90 percent.
- In the locations with more than 23.6°C temperature, buffalo might suffer from the change in physiological function and ovaries. Therefore, ensure enough drinking water and water bath areas.
- In mid hills, ensure proper drainage on the cauliflower nursery as there is the chance of light to moderate rain in an upcoming week.
- The temperature will increase in next week as per weekly weather outlook, spray water two to three times per day on high milk yielding buffalo or cow to reduce the heat stress.
- There is the chance of light to moderate rain in most of the days of the upcoming week, air dry grasses grown in the damp areas for a day to reduce the Cyanide concentration.
- There is the change of increasing temperature by 1-2°C, therefore, exchange pond water on a regular basis and use an aerator to ensure enough oxygen for fish.

F. Dissemination mechanism of agro-met advisory

The agro-med advisory is being disseminated on the day it is prepared. At first, the advisories are distributed to various technical and media personates through email. The FM radios in each district broadcasted the advisories through a scheduled program to reach to the farmers as agro-information "Krishi Suchana." Significant advisories are sent to farmers, farmer's group/ co-operatives and other stakeholders through Mobile Short Message Service (SMS) as Krishi Info-SMS in collaboration with Nepal Telecom (NT) by PPCR-BRCH Component D office under MoAD. For this service, free SIM card and mobile has been distributed to the farmers or farmer's groups/ co-operative members without any cost. The bulletin is also being uploaded in NARC official website.

Moreover, AMIS has provided fifteen megabytes data for those farmers receiving the mobiles. The bulletin prepared under PPCR program is also being disseminated by uploading to mobile application "Hamro Krishi." Furthermore, the bulletin prepared under the FAO program to "FAO-CCA" mobile application. Besides these activities, the feedback is also regularly being collected from the different beneficiary's group through email, phone, and other people as well as official contacts. Moreover, the information is also being transmitted through the various publications.

G. Lesson learnt and the away forward

We cannot deny the fact that agro-met advisory possesses a lot of scope to help farmers for combating against the weather variability as well as the climate change. However, there is still lots work to be done to make it very efficient and effective. At first, there should be enough research to explore the functional relationship of agriculture to weather parameters so that the information generated will be more reliable and accurate to native conditions. Secondly, the weather outlook should be in higher spatial resolution to catch the specific niches or microclimate in the country like Nepal with very high

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topographical as well as climatic variation. Third, farmers should be encouraged to follow the agro-met advisory employing the various packages and subsidies to make them dependable on week advance agro-met information. Moreover, the government should have a sustainable plan on continuing the agro-met advisory and should establish a perfect modality of practicing agro-met advisory services at each province level.

III. Conclusion

The agriculture is being hit by various weather processes qualitatively, quantitatively and economically. The information on the weather forecast and its application to generate the advisory on the agriculture sector help to optimize the agriculture production activities per weather and resources available. The agro-met advisory practices in Nepal have not only kept the scientific knowledge on the track for helping farmers on a weekly basis but also providing a lot of lesson on how to make the plan in future. One of biggest current challenges is to collect the crop and livestock status and agro-advisory dissemination as the country is implementing the new constitution as most of the extension mechanisms are under state and local government. The agro-advisory could be made more reliable and applicable given reliable niche-based high-resolution weather forecast and intensive agro-meteorological research in various agro-climatic conditions of Nepal.

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