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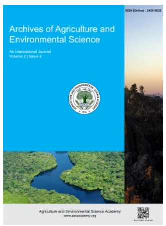

CASE STUDY

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Effect of unseasonal rainfall on rice production in Nepal during the year 2021: A case study

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ABSTRACT

Our study explicit the information regarding the status losses and the compensation amount We browsed the website of Ministry of Agriculture and Livestock Development (MoALD) and visited Agriculture Knowledge Centre to obtain the information. Rice is a major cereal crop, contributing around 25% of GDP and majority of working population are engaged in rice production for at least half year. Increasing population and pernicious natural hazards had declined the rice production leading to increment in import of rice from neighboring countries. Nepal received 15% more rain than average monsoon in year 2021. Flooding in various areas of Nepal occurred, causing huge loss of rice production along with destruction of lives and property indirectly leading to food insecurity. The onset of heavy unseasonal monsoon, occurred at the period when rice crops were ready to harvest or ready to thresh, undermined the labor, time and money invested by the farmers. The total rice production has been reduced to 5.13 million tons in 2021 from 5.55 million tons in 2020 at the rate of 8.74%. Lumbini Province faced the highest loss, followed by Sudarpaschim Province of Nepal. Climate change was the major factor responsible for this, hampering the agricultural productivity. Government of Nepal had decided to provide compensation to them based on three categories: small farmers having holdings of up to 10 katthas received compensation of 65% of their cost of production , medium farmers having land holdings from 11 to 40 katthas received 30% of their cost of production ,the large farmers having land holdings more than 40 katthas received compensation 20% of their cost of production. Also, the partially affected farmers received compensation 20% of their cost of production.

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INTRODUCTION

Rice is a major cereal crop grown in three agro-ecological zones, namely Terai, mid-hills, and high hills of Nepal, accounting for about 50% of the total agricultural area and production in Nepal. Around three-quarters of the total rice area is located in the flat plains of Terai. It contributes around 25% of GDP and more than 80% working population were engaged in rice production for at least six months a year. Increasing population and natural hazards had reduced the rice production and favored the import of rice. Mostly in urban areas, peoples are shifting their dietary towards rice due to increased income, favorable government pricing policies as well as good storability of rice (Awoderu, 1987). Asadh 15 is declared as "National Rice Day" on Nepali calendar by government of Nepal. Rice is considered as major source of income for the poor people and it is need of focus on this sector to improve their economic condition.

Rice production for Nepal was 5,550,878 tons and it increased from 2.34 million tons in 1971 to 5.55 million tons in 2020 growing at 2.71% average annual rate, but unfortunately, it decreased by 8.74% to 5.13 million tons in 2021 which is five years low despite a rise in areas cultivated for paddy due to post monsoon in October. It is the serious issue of all the farmers dependent on rice production and serious concern is needed in this sector. It was cultivated in 1,477,378 hectares of land in year 2021 which is around 4,000 hectares more than previous year. The total coverage of improved rice is around 921% and they express their yield potentiality only when recommended packages are practiced. Normally, rice production is highly correlated with amount and distribution of summer monsoon rainfall, occurring from June to September (Khanal *et al.*, 2018). According to Department of Hydrology and Meteorology, Nepal received 15% more rain than average monsoon in year 2021. Flood causes huge loss of rice productions along with destruction of lives and property (Hasegawa *et al.*, 2009), indirectly leading to food insecurity (Alam *et al.*, 2012). In Manang valley of Nepal, rain shadow brought with its flashflood which causes massive damage in seven hydropower plants, and Nepal's most expensive project, Melamchi water Supply. Standing crops were submerged and the harvested rice stalks were destroyed right across Nepal. Even after receding of flood, it creates a soil salinity condition and degrades the soil structure (Dasgupta *et al.*, 2015). Climate change has adversely affected the rice production and many vegetables as well (Auffhammer *et al.*, 2012; Fischer *et al.*, 2015). Causes of unseasonal rainfall should be well known among the peoples in order to cope with these problems effectively. Farmers should be trained with disaster management strategies, maintenance of proper drainage, climate smart agriculture practices so that they can be able to somehow mitigate the many hazards.

In recent years, extreme weather patterns have caused unseasonal biotic and abiotic stresses in rice production, affecting crop yield or leading to crop failure (Miah *et al.*, 2010). The impact of future climate change on agricultural production has been observed with crop simulation models (Mall and Aggrawal, 2002). Knowledge of intensive rice farming using best rice varieties along with best management practices is needed to increase the rice production, productivity and profitability but it hasn't happened due to lack of training, adequate and quality inputs, seasonal variations in rainfall (Sharma, 2016) and climate change (Le Dang *et al.*, 2014). Strengthening of knowledge base and developing information and monitoring systems for the area susceptible to flood is a significant in climate change adaptation planning (Nagabhatla *et al.*, 2012). Our study focuses on the status of rice production Nepal and the reason behind its reduction status in comparison to previous year. It also focuses on the causes of unseasonal rainfall, its detrimental effects and makes people aware of it so that they can adopt climate smart strategies to cope with this problem. Also, we had illustrated the compensation provided by the government and provided recommendations t the farmers.

METHODOLOGY

We had conducted our study with the view of showing the effects of unseasonal rainfall occurred in Nepal along with other countries to make people acquainted with this information. We visited the various areas affected with unseasonal rainfall and observed the conditions of rice crops. We obtained the required information from those areas, captured the condition of rice crops in the photographs. To get the information regarding the status losses and the compensation amount, we browsed the website of Ministry of Agriculture and Livestock Development (MoALD) and visited Agriculture Knowledge Centre. Finally, we reported our collected information.

CURRENT STATISTICS OF RICE PRODUCTION IN NEPAL

The unseasonal rainfall had hampered many areas of Nepal and other countries as well. It had damaged the agricultural crops, especially paddy which is worth of billions of rupees across Nepal. Total rice production has been reduced to 5.13 million tons in 2021 from 5.55 million tons in 2020 at the rate of 8.74%. Nepal's Far-Western Province lying on the side of Mahakali River is affected by floods, landslides as well as submerged rice condition. According to the preliminary report of Ministry of Agriculture and Livestock, floods as well as landslides had damaged paddy crops worth more than 7 billion in three provinces of Nepal namely Far-western, Lumbini and province 1.

Table 1. Rice Production status since 2009.

Year	Rice yield (million tons)
2021	5.13
2020	5.55
2019	5.61
2018	5.15
2017	5.23
2016	4.29
2015	4.78
2014	5.04
2013	4.50
2012	5.07
2011	4.46
2010	4.02
2009	4.52

(Source: Ministry of Agriculture and Livestock Development, 2021).

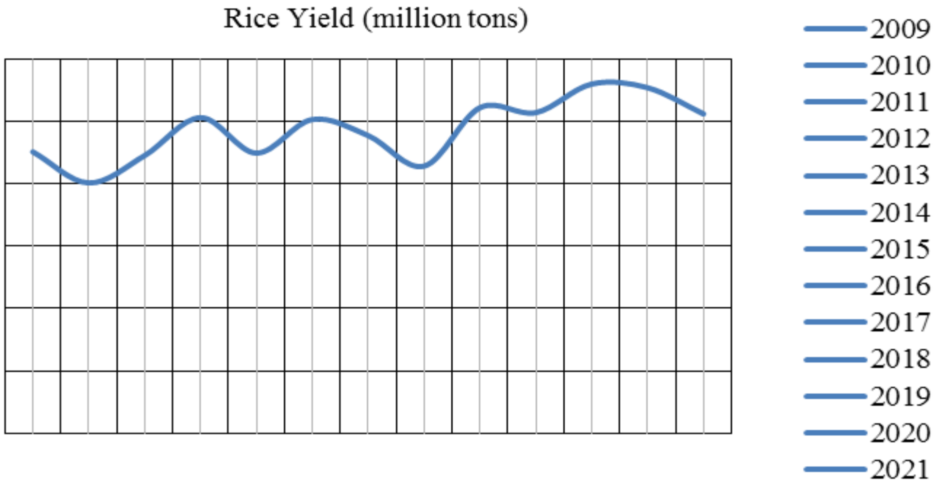

Figure 1. *Trends of Rice Production since 2009.*

Table 1. Losses at different Provinces, highly affected areas only, of Nepal in Monetary basis.

Province (highly affected districts)	Losses in those areas(Rs. in billions) worth of
Lumbini (Bardiya, Kapilvastu, Banke, Nawalparasi)	4.51
Sudurpaschim (Kailali, Kanchanpur)	1.91
Province 1 (Jhapa, Morang, Sunsari)	0.8
Karnali (Dolpa, Jumla, Salyan, Surkhet)	0.3
Province 2(Chitwan, Nuwakot)	0.56
Gandaki(Syanja, Nawalparasi, Kaski)	0.13
Bagmati	0.058

(Source: Ministry of Agriculture and Livestock Development, 2021).

CURRENT STATUS OF LOSS CAUSED BY UNSEASONAL RAINFALL ON RICE PRODUCTIVITY

Rainfall started on October 17 in western part of Nepal. Later, it moved to eastern part in October 19 claiming the lives, damaging roads and bridges along with agricultural produce including rice. Lumbini Province suffered the highest losses as heavy rains damagesd more than 161,000 tons of rice worth Rs. 4.51 billion. Bardia, Kapilvastu, Banke and Nawalparasi were the key affected areas where the floods had swept away or submerged the rice crops on more than 42,000 hectares area. In Sudurpaschim Province, Kailali and Kanchanpur districts were highly affected by heavy rainfall, resulting damage of 68,400 tons of rice on area of 18,000 hectares and the total loss in this province had been estimate3d at Rs. 1.91 billion.

In province 1, Jhapa, Morang and Sunsari district were severely affected. More than 28,400 tons of rice on area 7,492 had been destroyed, resulted on total loss worth of Rs 800 million. Province 2, especially Saptari, Siraha and Sarlahi districts, faced a loss worth of around Rs 560 million, where 20,350 tons of rice planted on area 5,355 hectares have been damaged. Karnali Province suffered a damage worth of Rs300 million which includes more than 40,200 tons of rice on 10,584 hectares in Dolpa, Jumla, Salyan, and Surkhet district of this province. In Bagmati province, a 2,068 tons rice worth of Rs 58 million planted 530 hectares area were destroyed by rainfall in Chitwan and Nuwakot district. More than 4,500 tons of rice on 1,192 hectares had been destroyed in Gandaki province where Syangja, Nawalparasi and Kaski suffered combined loss of worth Rs 130 million.

CLIMATE CHANGE: CAUSE OF UNSEASONAL RAINFALL

Climate change, being the emerging threats in recent days, has hampered agricultural as well as non- agricultural sectors. The Himalayan Mountains are warming between 0.3-0.7°C faster than the average, causing glaciers to shrink, the snowlines to recede as well as increasing the danger of floods when expanding glacial lake to burst. There was unusual, incessant heavy rainfall and snow used to fall. The fragile moraine ridges below Kanjiroba dissolved, causing debris flow down the village below. A similar flood on Melamchi river damaged Kathmandu water supply project which was the most expensive project of Nepal. Record breaking rainfall had initiated deadly floods in Manang district of Nepal. There is copious amount of evidence that extreme rainfall was triggered by climate change. The Intergovernmental Panel on climate change (IPCC) approximation for 2050 demonstrate that changing rainfall patterns and increasing temperature along with flooding, droughts and salinity, resulting due to climate change, will possibly decline rice production by 8% against 1990 baseline production values (Cancelliere *et al.*, 2007). For every one degree Celsius, air can hold 7% more water vapor as climate change warms up the atmosphere. Water vapor turns into droplets which joins together to form heavy rainfall, as the air rapidly cools. Heavy rainfall for several days, even a week, leads to overflows of rivers, dams etc reaching towards cultivated areas. Scientific studies, in recent days, focus more on investigating the climate change and extremes at large scales (Revi, 2008). Rice production has faced the harmful effect of climate change in year 2021: climate change changes the patterns of seasonal rainfall, its intensity and frequency, resulting in unseasonal rainfall which destroys the rice production and the area cultivated with rice. October remains to be the vital months in Nepal, as planted rice in monsoon were harvested in this time.

Detrimental effects

Unseasonal rainfall, occurred incessantly during the month of October in Nepal, undermined the huge amount of agricultural produce of many farmers. Farmers of various areas suffered a huge loss of agricultural produces along with lives and property. Numerous researchers have shown flood damage functions as well as damage assessment method for direct flood damage to physical property (Thapa *et al*., 2020), household contents (Win *et al*., 2018), infrastructures (Glas *et al*., 2016), as well as industrial sectors (Zabret *et al*., 2018). However, in the development of flood damage functions for agricultural sectors, such as flood damage to rice crops, there is limited research (Win *et al*., 2020). Those who had invested their time, money and labor in producing the rice suffered a lot as the monsoon time coincide with harvesting time of rice. Unseasonal rainfall damaged rice crops worth of around 26 billion (MoALD, 2021). The ministry estimated that the ready-to-harvest rice crops on 85,580 hectares had been swept away or submerged by the flood water in all provinces of Nepal. Erosion along with soil displacement caused by flooding undermined the fields and destroys the crops. It washes the top fertile soil away leaving crop plants with nowhere to set roots and the deposition of rocks, sand and gravels deposited smother as well as destroys the crops. The increment in the precipitation, including in Manang valley in Nepal's rain shadow brought with flashflood caused the huge loss in that area as well.

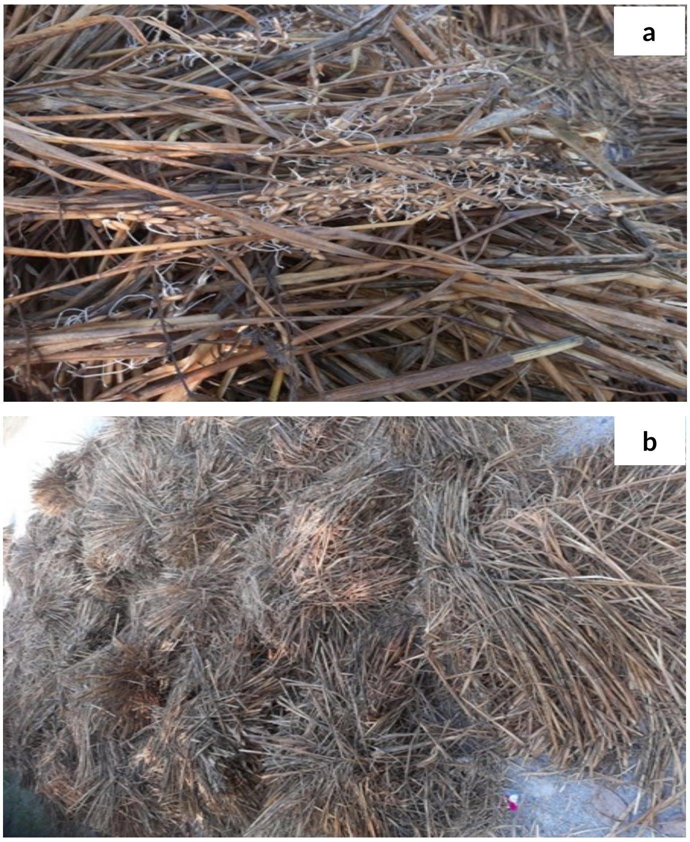

Figure 2(a,b). *Condition of rice crops due to incessant unseasonal rainfall.*

Farmers have to work hard almost 190 days to get the pay back of their investment but in 2021, they had suffered a lot due to heavy rain, caused by climate change. It resulted in massive flooding and landslides across the country. Majority of farmers and their families were in deep grief as hundreds of thousands of hectares of ready-to-harvest paddy are submerged in water along with large amount of paddy taken away by flood. Completely submergence of rice crops causes complete damage to crops (Win *et al*., 2020). More than 50% damage occurs within 3 days of flooding for completely submerged rice crop at reproductive as well as maturity stages (Shrestha *et al*., 2016). They even didn't get sufficient place to sundry the recovered rice crops from the flood: they spread the recovered wet rice crops all over the sides of roads which had somehow hindered the transportation. Problem of sprouting appeared in the rice crops recovered from the flood condition and were found difficult to thresh. Even after threshing with difficulty, some grains were obtained with less market value in terms of quality as well as quantity. Climate change is affecting rice production by higher temperature, drought as, flooding, soil erosion, salinity as well as rainfall variation across the globe (Fisher *et al*., 2015; Rahman *et al*., 2017).

COMPENSATION GIVEN BY GOVERNMENT TO THE AFFECTED FARMERS

Thousands of tons of ready-to-harvest rice crops were submerged and harvested but ready-to-thresh rice were swept away by flood. Agricultural ministry said that unseasonal rainfall had caused losses of altogether around 424,113 tons of rice planted on 111,609 hectares which is worth of around Rs 11.87billions. As their quality along with quantity is ruined, submerged rice after recovery lost their value in market. It has caused farmers to suffer food insecurity. To make the farmers free from hunger, compensation scheme was announced by government of Nepal. Compensation is of utmost importance to the ones who has lost the means of survival (Venkatachalam, 2005). Government of Nepal announced a compensation of around Rs. 5.52 billion for the farmers who lost their paddy crops due to unseasonal heavy rainfall. This amount is the highest ever aid package approved so far for the farmers in Nepal. There are different ways of loss determination and compensation (Goudappa *et al*.,2012). Government of Nepal distributed cash in three categories. Government provided compensation 65% of the cost of production of small farmers. Small farmers, whose crops have been completely destroyed, having holdings of up to 10 katthas received Rs. 1,921 per kattha as a compensation amount. Likewise, Government provided medium farmers, having land holdings from 11 to 40 katthas, compensation 30% of their cost of production which was Rs887 per kattha. For the large farmers, having land holdings more than 40 katthas, received compensation 20% of their cost of production which is Rs591 per katthas. Also, to the partially affected farmers, Government provided compensation 20% of their cost of production which is Rs591 per kattha same as for large farmers (MOAD, 2021).

Conclusion and recommendation

Unseasonal rainfall had hampered the lives, property and agricultural produce including rice crops of many farmers. It had created food insecurity. Climate change is the main reason behind the change in the rainfall pattern and causing the unseasonal rainfall. Production of rice was decreased this year than previous year due to unseasonal rainfall effects. Lumbini and Sudarpaschim provinces were largely affected causing heavy loss of rice crops. Ripened ready to harvest and harvested ready to thresh rice crops were damaged through submergence or swept away by flood water. Government had also provided compensation to the affected farmers based on three categories; small, medium and large farmers. Climate change should be controlled by minimizing the emission of greenhouses gases which changes the climatic condition in later years causing heavy losses. Disaster management schemes must to formulated and implemented by the Government of Nepal to minimize the risk of flood. Good drainage schemes must be facilitated so that excess flood water can be drain out from the rice fields. Farmers should be updated with the recent weather patterns without being dependent on previous weather pattern. Climate is capricious nowadays: no one knows what will happen in upcoming time periods. Being updated with climatic or weather condition, one can harvest his crops to escape the unwanted accidents. Government needs to concern in these areas as climate change is being the serious issues in recent years. Majority of farmers were dependent on agriculture and rice is a major cereal crop grown by them, it all depends on climate; climate change must be given serious attention. Each time, compensation is not only the solution, concrete plans, policies and strategies must be adopted for the resilience against flood and climate change. Government should undertake many actions such as, the cloud-based monitoring system for your government data, establishing areas known for flooding as flood zones and building water diversions such as dams or dikes to control flood. Provision of better flood warning system, protection of wetlands and introduction of new plants strategically seems beneficial along with other strategies to tackle climate change. Non-governmental organization must be encouraged to work in disaster affected areas. Mass trainings, literacy as well as awareness programs and campaigns should be launched so that they will make people aware. Many scientific studies are required to recognize flood risks. The disaster information management systems should be institutionalized at every level of government. Collaboration needs to be done with worldwide cooperation in order to expertise and technology transfer such as drones and robots for catastrophe tracking as well as damage evaluation. Government should conduct strategic plans to minimize the climate change and its effect, which prevents the unseasonal rainfall and rice production won't be hampered. Our study presented the conditions of rice production and the possible recommendation so that people became aware of these.

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