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Opportunities and Challenges in Irrigation Practices and Agricultural productivity scenario in Nepal: A Review

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Abstract

Since 1928 (1985 B.S) modern irrigation system was started after the construction of Chandra Nahar as a first modern canal of Nepal. Before that farmer managed small channels were used for irrigation in hill and rain fed agriculture was in Terai region .Gradually small, medium and large type canal were developed for irrigation practices which made irrigable land area 1.4 million ha out of total 1.77 million ha cultivable land of Nepal. However its contribution on national economy is insignificant as compared to the rain- fed agriculture in the past. The contribution dropped from 60% to 20% during the years 1965 to 2020.This review study concluded to investigate the challenges and opportunities in irrigation practices and productivity trend scenario of major crops rice, maize, wheat and vegetables in Nepal. Despite the ample amount of water resources as gift of nature the irrigation development is still in infancy stage in Nepal. The irrigation practices are still facing challenge of poor river management, lack of socio co-ordination among users, market problems and poor technical skill and knowledge of irrigation practices on user level. Natural calamities like flood, landslides are severe problems for agriculture sector every year. Despite these problems and challenges the opportunity to make the system sustainable can creates job and helps to improve the economic status of the people from agriculture sector. At low budget allocated for agriculture sector 2 to 4% of the national budget the rapid development is impossible in irrigation as it requires huge investment. From the existing irrigation systems the productivity rate found increased in recent years for all crops. But with the increase in population the food product are insufficient to fulfill the demand. So therefore the import trend is fond rising up every year. The import cost for rice is maximum at the year 2021. Import cost on maize is greater than for wheat and vegetables. The import trend showed alarming situation for the national economy. If it hikes up with the same rate the national economy may collapse in near future. So only sustainable irrigation practices can boost up the agriculture productivity and minimizes the import cost.

Keywords: Sustainable Irrigation Practices, Agriculture Productivity Trend Scenario

Introduction

Nepal is land locked mountainous agriculture based country in south Asia having total area of 147516 Km2. At the beginning of 19th BS the country's economy was 80% based on agricultural product [1]. The agriculture system was completely traditional and managed by village farmers in Hill and Terai of Nepal. However the country's dependency on foreign import was minimum in agricultural products. Only for salt and sugar country was dependent to neighboring countries china (Tibet) and India (north and south.). But at present many questions are raised up in agriculture sector about its future in Nepal. Whether it will be worst conditions or will be better in near future. Whether it will be attractive profession for youth or not. Such questions are rising up from the experts' level. The prosperity of nation is uncertain due to the degradation on agricultural and its low contribution on national economy every year.

The development in agricultural productivity is directly related with the sustainable development of irrigation system and practices [2]. Without sustainability in irrigation system the development in agriculture is impossible as irrigation and agriculture are interrelated to each other. To accelerate the agricultural productivity development of irrigation project is necessary in parallel. But the scenario is different. Demotivation toward agriculture, choice of other occupation, brain drain, and movement of youth towards foreign for the opportunity of employment, increasing natural disasters, the problems facing by farmers from the poor government policy and insufficient facilities are causing more challenges on agriculture field. However many opportunity can be created if government gives more attention with sufficient facilities and sustainable development on irrigation and agriculture sector. So this study is aimed to make an overview of the current status of irrigation development practices and Agriculture sector in Nepal such that some practical suggestions and alternatives would be achieved that will boost up for sustainable development in agriculture which ultimately will be beneficial for national economic growth and prosperity of the nation.

Objectives of the Study

The main objective of this study is to review the major challenges and opportunities of irrigation and agriculture practices in Nepal. The study includes the following specific objectives.

1. To review the status of irrigation development practices.
2. To review the challenges that Nepalese farmer are facing in irrigation practices.
3. To review the agricultural productivity trend, its sufficiency for the country and its contribution on national economic growth.

Research Methodology

This review study is purely based on secondary data from FAO, WFO, WTO, MODA, DOA, ADB, WB and NARC which included the published and unpublished data. The main data of crops rice, wheat, maize and vegetables are taken as a major reference for the study as these foods are the main crop production of the country. The irrigation development and its practices in both hill and Terai irrigation schemes (surface and sub surfaces sources) are considered for the study.

Literature Review

Nepal is a mountainous country located in between two giant countries India and China in south and north (emerging powerful countries of the world). The development of these two nations in the field of modern irrigation and agriculture development are so remarkable that the food product from these two countries are imported to the worlds people and making the nation GDP highest in the world rank [3-5].But the history of modern irrigation system was started in Nepal before India. Nepal has started agriculture production with the first modern irrigation system by Chandra Nahar constructed at 1928 (1985 B.S) in Rana Regime which was for the Saptari District of province 2 of Nepal and still in operation. Before that the agricultural system was farmer based and traditional. The irrigation system was small channel made by village farmers called Kulo in hill and in Terai region it was hard to use surface water for irrigation and only ground water was in use for irrigation by pumping. Still the surface and ground water are in use in terai region for irrigation. Also the dependency on rain water is still in Nepal during monsoon. However the modern big irrigation canals were developed for plain region. Major irrigation canal such as Kankai, Sunsari Morang irrigation project, kamala irrigation canal, Bagmati irrigation canal, Narayani irrigation canal, Gandak, Babai, siktta irrigation canal were constructed in terai region where as in hilly area the farmer managed irrigation canal were upgraded with the help of Nepal government and different NGO, INGO,ADB projects in hills [6]. These canals are used for the main crops like rice, wheat, maize, sugarcane and vegetables productions of the country. At present date Nepal has now 1.4 million ha of irrigated land out of 1.77s million ha potential irrigable area [7]. Despite the huge surface water sources, Nepal is still depending on underground water and rain water harvesting for irrigation. Irrigation development work is still in infancy stage in Nepal. The figure1 below is the land use and land cover map of Nepal clipped from ESRI for 2020 which shows the all land features in 10 meter resolution. The southern part is plain region having large agriculture land area of Nepal. And figure 2 is the major River basin of Nepal showing huge surface water potential [8].

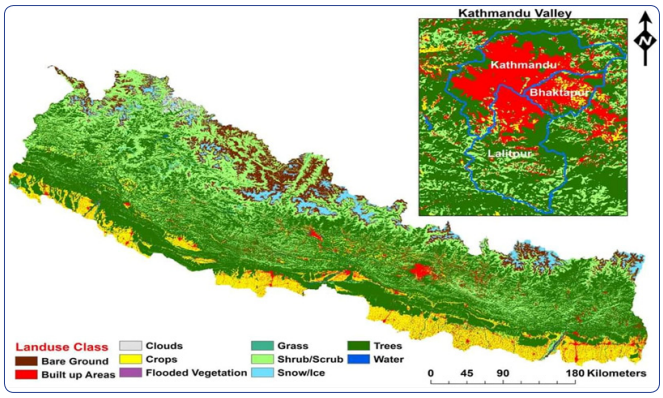


Figure 1: Land use and land cover map of Nepal clipped from ESRI 2020 at 10 meter resolution

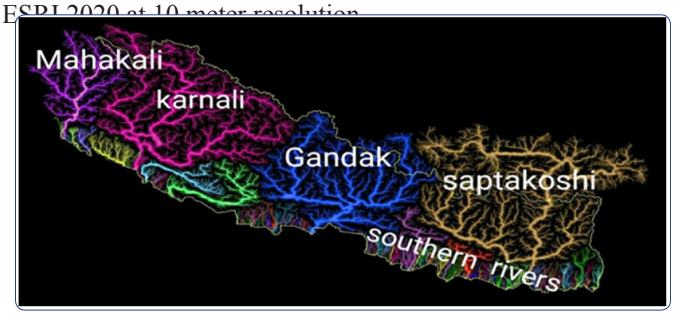


Figure 2: Major river basin of Nepal generated on ARC GIS

Development of Irrigation and its Practices in Nepal

Irrigation is an artificial application of water to the crop which is a planned action in the shortage of rainfall especially in dry seasons. It helps to fulfill the food demands to the increased population by the increase in food production. For reliable and sustainable food security the development of irrigation and expanding it on large scale through river diversion constructing dam is essential. In case of Nepal the population is increased three times from the year 1955 to 2020 as shown in Figure 3.With the increase of population the food demand increases naturally. Also for the country like Nepal only one alternative to improve the national economy is agriculture which creates the employment too. It was considered as a reliable basis for food security and tool for prosperity of rural people in Nepal. So modern irrigation system was started at 1928 with the construction of Chandra Nahar (Figure 4) of Saptari district of Nepal (Province -2) at Rana regime for rice, wheat and maize crops. This canal is still in use and it uses water from Triyuga River of Udaypur District that meets Spatkoshi River. After that Raj Kulo was constructed for Kathmandu valley at same time .Then later the irrigated agriculture practices started all over the country gradually.

The irrigation system were started to develop in three forms as small, medium and large in Nepal [9]. In hilly area small scale canal were constructed as farmer managed irrigation canal (FMIS). Such as Soyak irrigation system Ilam,Pithuwwa Irrigation system Chitwan, Subedar ko Kulo Sindhupalchok ,Leguwa irrigation system Palpa, Baghkhor kulo Surkhet are the main farmer managed irrigation canal in hilly region [6]. In terai medium and large size projects were developed. The major canal constructed were kankai irrigation canal of 3000 ha command area, sunsari Morang irrigation canal of 2000 ha command area, Bagmati irrigation canal of 32000 ha command area, koshi western canal and pump canal of

24280 ha command area, Khutia 3500 ha command area, Mohana 2000 ha command area and Mahakali 1900 ha command area. Also Nation pride project Babai irrigation project is implemented by the Ministry of Energy, water Resources and Irrigation aim to irrigate 36000 ha of land using Babai River in west Nepal. Similarly another national pride project Sikta from Rapti River has started to irrigate the land area of 43000 ha [2,10].However it is not able to give services in full capacity due to structural failure and investigation is going on. Figure 5 is the embankment failure while testing of this project and after repair and maintenance work it is under operation with low discharge. As compared to the water resources potential available the development of irrigation system is not sufficient. River networking project is feasible in case of Nepal for irrigation purposes but still government is not well prepared for the implementation and is limited in paper documentation work. Government is lagging to develop more irrigation projects due to different uncertainties.

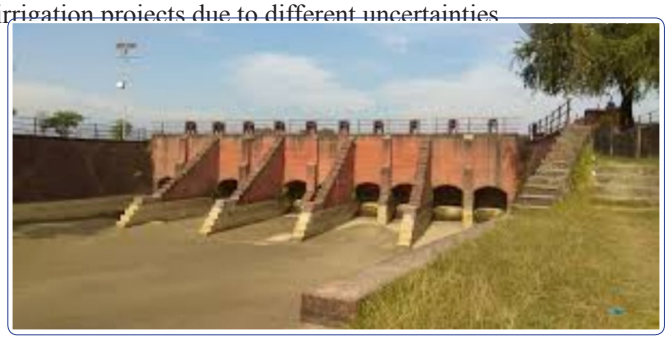


Figure 3: Intake structure of Nepal first irrigation canal Chandra Nahar (1846) (**Source:**DOI)

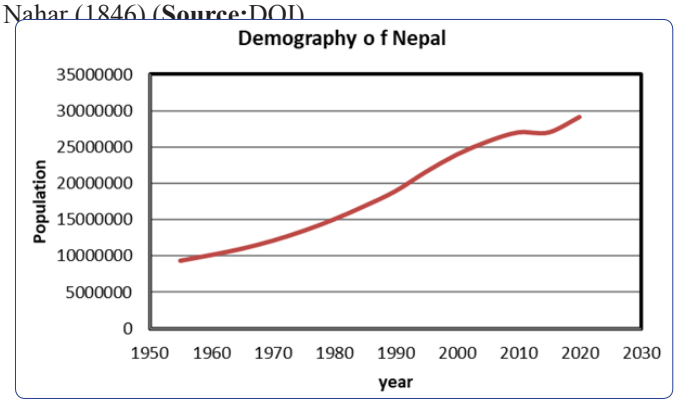


Figure 4: Demography of Nepal from the year 1955 to 2020

Challenges Facing Irrigation Practices

Difficult in Scheme Management

Most of the irrigation canals of Nepal are under severe challenges of siltation or sedimentation problems. The sediment concentration in river is so high that to manage the sediment deposition in the agriculture field is a difficult task in Nepal. It also creates problems in the headworks structures like settling basin and along the canal reach due to sand deposition [11]. It reduces the efficiency of canal abruptly that affects to the water carrying capacity of canal system. The soil saltation and its effects on the mega project of Nepal was also a huge loss in case of national pride irrigation project sikta. The failure of the canal on testing is shown in figures below. After repair and maintenance it is under operation at low flow rate.

Figure 5: Embankment failure of Sikta irrigation project due to saltation in soil.(source: DOI)

Socio Institutional Problem

In case of Nepalese consumers there is low level of co- ordination to use water. The upstream users get more benefits than the downstream users. This causes unequal distribution of water and ultimately it affects to the production rate. In many cases at the downstream area both surface and groundwater is to be used for irrigation. There are no clear cut rules regulations and responsibilities to manage these problems through an institutional set up.

Insufficient Technical skills

Most of the Nepalese farmers are unknown about crop water requirement, its interval and use of fertilizers .When and how to use water and fertilizer they have no ideas. They have no ideas about water application method and lack of knowledge on water management aspects resulted the wastage of water, deterioration of structures and water logging problems which ultimately reduces the productivity of the land. Also farmers are unknown about the technical problems like seepage, evapotranspiration. They do not know about the crop types and its requirements. They just irrigate the crop on the basis of guessing. It is all due to lack of technical support from the concerned department.

Financial Shortage

The input to the production like fertilizer, improved seed and chemical needs high financial input for purchasing. Most of the Nepalese farmers are incapable to afford it. The equity and equality for the facility is not developed by the government. The poor agriculture policy, minimum budgeting for agriculture sector is the major problems for the degradation on agriculture product and less interest toward this profession in new generation [12]. Nepalese farmer has bitter experience of shortage of fertilizer every year on crop seasons.

Market Problem

Market problem is global for poor countries [13]. Nepalese farmers are suffering from the market problem. Due to the lack of food storage they are forced to sell their product at low cost and buy the same food at high price later. There is no any government set up to take the risk and buy and sell policy. This affects to the irrigation practices and demotivate to the farmers always.

Natural Hazards

Uneven rainfall, drought also causes the problems for farmers every year. The landslides, flood in river inundates the agriculture land each year [14]. Physical property loss, life loss are unpredictable every year in Nepal. The flood in Melamchi River this year and its devastation to the agriculture and human settlement are unmeasurable. The figure6.1 and 6.2 shows the

devastation of the city and agriculture land of the Nepalese farmer due to heavy rainfall and flood this year 2021. This is a serious problem for poor countries like Nepal which cannot afford to manage and control such unexpected natural hazards. In case of Nepal landslides and flood is a severe problems each year [16].

Figure 6.1: Melamchi Bazar before damage in 2021 Sindhupalchok, Nepal (Source: DODM)

Figure 6.2: Damage due to flood and land slide (2021) on Melamchi bazar and Agriculture land of Sindhupalhik (DODM)

Opportunities of the Irrigation Practices

At the present scenario sustainable development of irrigation practices contributes to increase food production, promotes economy and creates job opportunities that reduces poverty and also protects the environment from pollution. It increases the ground water level through recharging. Since the world is suffering from pandemic of covid-19 the world's economy is in degradation. People are losing their job and unemployment is a great challenge for people and their everyday life is becoming hard. In the lack of job the impact on poor people is tragic. They are unable to afford for food and health care. For easy life Nepal has only one option to make effective planning, policy and facilities to attract the youth in agriculture profession. Agriculture is the only one sector that can creates the job opportunity and make good income source in Nepal.

Agriculture Productivity Trend Scenario in Nepal

Nepal is gifted by ample amount of water resources by nature. But the use of water still in infancy stage. It can be used for hydropower development, water supply, irrigation for agriculture land, recreation as multi purposes projects. Irrigation development and its use in agriculture sector can contribute in large amount on socio economic development of the country but the national investment on this sector is insufficient and miger.The government budget for agriculture sector is not more than 2 to 4% of the total budget of the country. The figure 7 shows the budget distribution of Nepal for agriculture ministry. By such small budgeting the development of irrigation and agriculture sector is impossible today's date. So the experts of nation must give more concern while making national budget and its distribution.

Due to poor agriculture policy, unequal distribution of facilities to the farmers the interest toward the agriculture work is degraded. Youth choices are not the agriculture job and want to move aboard for the job opportunity in industrial countries. Most of the young generations are working in gulf countries and nation is running with the help of remittance. Figure 8 shows the nation was dependent 80% on agriculture in 1990 and degraded each year and today the dependency is dropped into 60%. This is the indicator of future of agriculture sector in Nepal. In beginning of 1965 the contribution of agriculture sector in nation GDP was above 60% where as its trend was decline and today agriculture sector is limited to contribute only 20% in national economic development. This shows the destitute condition of agriculture sector in Nepal. Once upon a time Nepal was exporting foods to the neighboring countries bur today dependency is around 90% of food product.so it is alarming time for the nation. Figure 9 is the graph of agriculture contribution on national GDP of Nepal Generated by world trade organization (WTO).

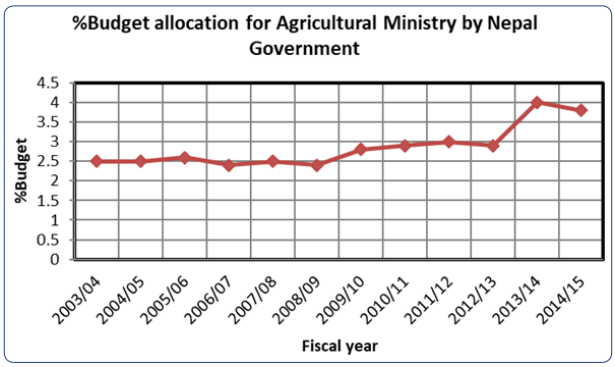


Figure 7: Budget allocation trend for agriculture sector by government of Nepal

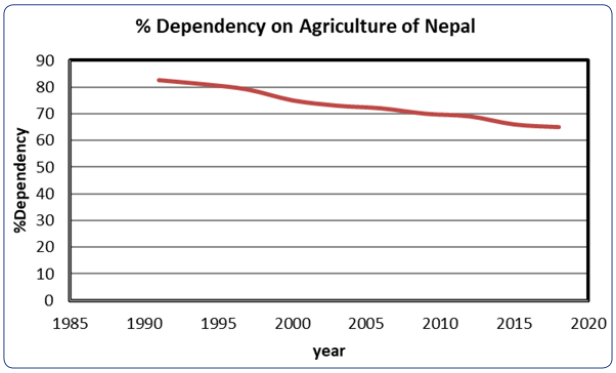


Figure 8: Dependency of people on agriculture profession of Nepal

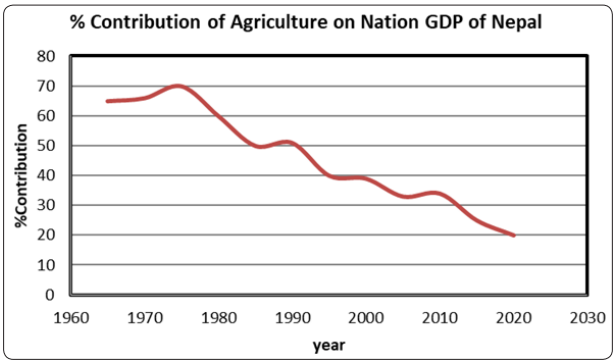


Figure 9: Contribution of Agriculture products on National GDP of Nepal

Trend of Rice Productivity

Rice is the major crop of Nepal [16] .Its area is about 1000000 ha since 1951 to till now including hill and plain. The plain region

of Nepal at southern part is the most fertile land for rice. So the major irrigation systems are developed for this region. However the irrigation system is not sufficient to supply water if rainfall does not occurs sufficiently. In terai the irrigation system is still from ground water and rainfall harvesting during monsoon. The combination of surface and subsurface water resources are in used by pumping in plain region. So it becomes more costly and causes of rapid depletion of ground water table due to excess abstraction for irrigation and water supply system. There is no recharging process in planned way so water balance is disturbed extremely. The development of irrigation system resulted increase in rice production from same area. But the population increase and crop production did not match. For this reason the import on rice is increasing every year which cause huge economic loss in rice import [17]. At the end of this year it was 2.66 billion paid to India for rice import. The graphs in figure 10 show the rice production and import in Nepal that indicates the rise in yield and import. But import is in higher rate than yield. So to control the import government must be alert from this indicator and must take effective action on land use and land cover management specially the loss of agriculture land must be protected from uneven city development and land plotting for housing area in agriculture field. The land plotting is major cause of agriculture area reduction.

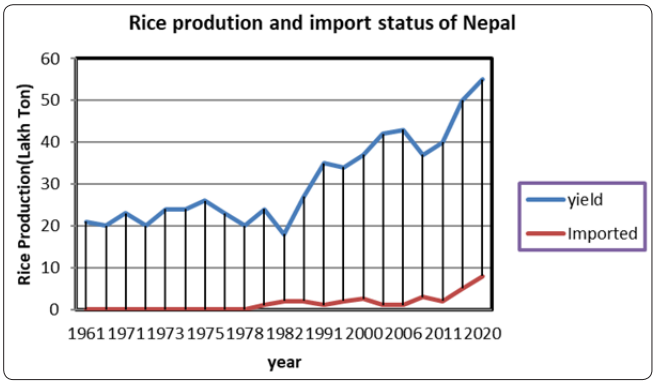
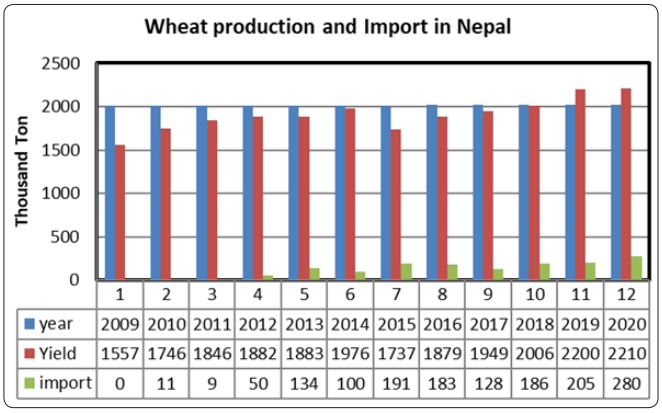


Figure 10: Yearly Rice production and Import scenario of Nepal

Wheat Productivity Trend

After rice and maize Wheat is another most important crop in Nepal [18]. Terai region is the appropriate area for wheat production. But it is also main crop in hill area of Nepal. The agriculture area for wheat is 762373 ha.The production data were observed from 2009 to 2020 of wheat in Nepal. The production rate found increased in a small margin. It was reported by NARC the increase in wheat production was due to variety of seed used. Now there are 26 type of seed are in use for wheat production. The fertilizer and chemicals also helped to promote the crop yield. But the import data showed the demand is not fulfilled by the production. Consumption of wheat is found increased every year. So the import is highest in year 2020. The imported cost in the year 2017 was highest as reported by WTO. Figure11 shows the production and import trend of wheat in Nepal. The cost for wheat import found increased in the later years as shown in figure12.



	1	2	3	4	5	6	7	8	9	10	11	12
year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Yield	1557	1746	1846	1882	1883	1976	1737	1879	1949	2006	2200	2210
import	0	11	9	50	134	100	191	183	128	186	205	280

Figure 11: yearly wheat production and Import scenario of Nepal

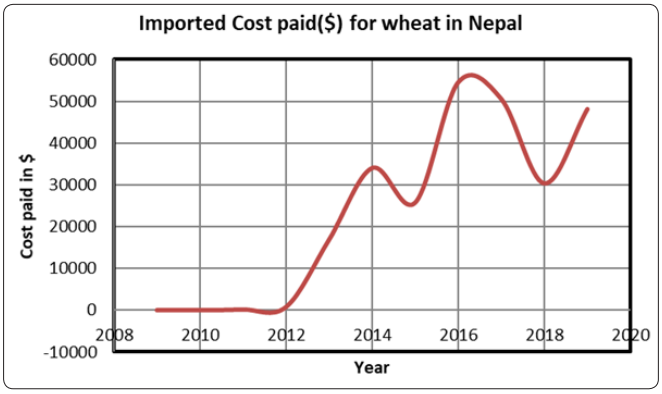
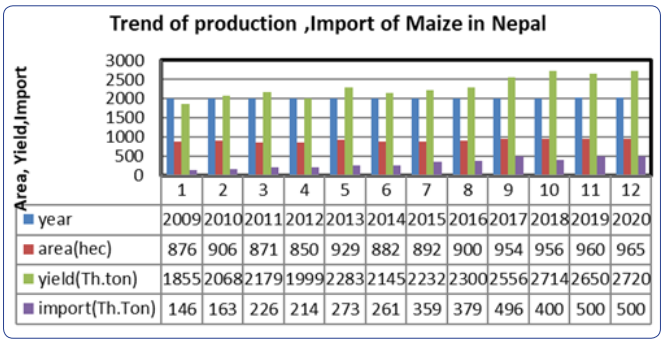


Figure 12: Yearly cost paid by Nepal for wheat import in dollar

Maize Productivity Trend

Maize is the second main crop of Nepal for both plain and hill area. Since it requires low irrigation water requirement the rainfall is sufficient for this crop. But the drought year may cause the low production in hill area where irrigation system is not available. From the data the area of maize crop is raising up during the year 2009 to 2020. It is found the area increased from 876 ha to 965 ha. Also the production rate is increased with the increase in agriculture area for maize.it 2020 it was highest amount of 2720 thousand ton. But the import data showed production could not fulfill the demand. Import rate was also found increased every year and highest in the year 2020. figure 13 shows the comparative trend analysis of yield and import of maize in Nepal. Data showed the import cost for maize is higher than that for wheat import. Figure 14 is the comparative graph for import cost of wheat and maize in Nepal.



	1	2	3	4	5	6	7	8	9	10	11	12
year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
area(hec)	876	906	871	850	929	882	892	900	954	956	960	965
yield(Th.ton)	1855	2068	2179	1999	2283	2145	2232	2300	2556	2714	2650	2720
import(Th.Ton)	146	163	226	214	273	261	359	379	496	400	500	500

Figure 13: Agriculture land area, production and import scenario of maize in Nepal

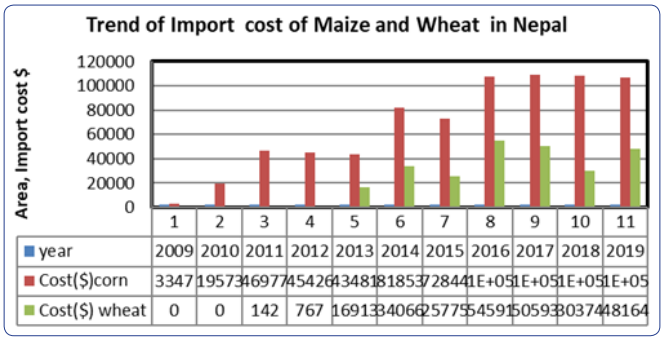


Figure 14: Comparative chart of yearly import cost for wheat and maize in Nepal

Vegetables Productivity Trend

The most common vegetable of Nepal are potatoes, tomatoes, cauliflower, brinjel, green leafy vegetables like mustard, spinach, radishes, squash, and other local vegetables. The agriculture area used for vegetable production is only 7.3 percent of the total cultivable land in Nepal (MOAD) and 55 types of vegetable are in production in Nepal. The total contribution of vegetable on national GDP is around 8.8% which is greater than that of wheat and maize. From the export import data, the import is higher than export during the years 2014 to 2018. It is observed that to reduce the import rate the production area of vegetables must be increased in significant amount. Figure 15 shows the export and import rate of vegetable in Nepal.

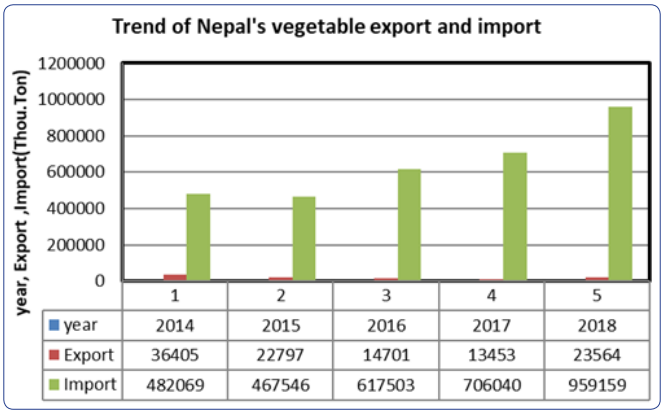


Figure 15: Export and import trend of vegetables of Nepal

Discussion

The study revealed that the irrigation development and its practices in Nepal are not sufficient till today. Still agriculture is based on monsoon rainwater in terai region. Groundwater extraction is large which is causing depletion on ground water table abruptly. The problems and challenges facing by the farmer are the factors for the demotivation towards this occupation due to which bare land is increasing all over the country. Farmers always feel unsecured at unsustainable irrigation system. Despite huge surface water potential and river network possibility government is not giving priority to such projects. With time the number of irrigation projects must be developed parallel. Due to old and insufficient irrigation system the cultivable land area is seemed constant for rice crop from years. With the extension of irrigation projects the cultivable area should be increased to raise the production which fulfills the food demand with the increase in population. The development work of big projects is seemed technically weak in construction due to which failure rate of civil structures are increased within the country. The sikta irrigation canal failure is one of the examples of poor construction work. With the available modern technology the construction work should be done. Old fashioned developments are not reliable. With proper river management the development work is needed. Environmental impact assessment is essential before the project planning. Heavy rainfall, floods, landslides are becoming sever problems for irrigation and agriculture in Nepal.

Similarly from study of the agriculture productivity scenario, the production rate found increased from the same land area in recent years. It was found the increase in production was result of the modern seeds, fertilizer and chemical used in the land. However the fertilizer is not available for Nepalese farmer enough and within time period of crop seasons. Also the purchasing capacity of farmers is low so they cannot buy the fertilizer as required amount. Government is completely failure to give such facilities to poor farmer of the country due to poor agriculture policy. The budget for agriculture development is of 2 to 4% of nation budget each year. It is not sufficient .It must me increased for investment on irrigation project development .with the increase in production rate the import on rice, wheat, maize and vegetable is increased. The export is negligible with compared to import amount. The cost on import for rice is highest on the year 2021 which is 40 billion Nepalese currencies. The import cost on maize is higher than for wheat. Import is fifty times greater than export in vegetable in the recent years and increasing every year. The agriculture area for vegetable production is very low which 7.3 % of total cultivable area is. The commercial vegetables production is necessary just to fulfill the demand within the country. From the productivity and export import trend analysis of the crops the dependency is above 80% to the foreign import. This is alarming situation for the national economy to be collapse in near future.

Conclusions and Suggestions

The study is an overview of opportunities and challenges of irrigation practices and productivity trend of major crops rice, maize, wheat and vegetables of Nepal. With the ample amount of surface water gifted by nature the dependency on rainfall for agriculture is a wretched condition for the country. With the increase in irrigation systems development the poverty of the people can be eliminated from agriculture as it creates employment opportunities to earn money. More the irrigation systems more will be cultivable land area which helps to increase in crop yields that can contribute in national GDP by increasing the export. To reduce the import scenario is big challenge for nation today. So from the study some suggestions are put that boost up the sustainable development on irrigation and agriculture sector.

1. There should be strong institutional set up with sufficient budget for the irrigation and agriculture sector.
2. The motivational facilities for poor farmers must be increased. Facilities of irrigation system, modern seeds, fertilizer in low cost and timely available must be ascertained from the concerned authority and department. The opportunities of technical training for poor people on irrigation use and market availability encourage to the poor farmers.
3. To save the fertile land is become a big problem. Land pooling and plotting is major cause of reduction if agriculture land today. The effective law and policy with action is must without any delay.
4. Provision of food storage ascertains the food security. The risk bearing policy from government side should be made.
5. The policy should be made to encourage use of national

product so that import will be low. The strategic policy and planning should be set as research institutions.

Abbreviation

FAO= food and agriculture organization
WFO= world food organization
WTO= world trade organization
MODA= ministry of department of agriculture
DOA= Department of Agriculture
ADB= Asian Development Bank
WB = World Bank
NARC=Nepal agriculture research Centre
DOI= Department of Irrigation

Competing Interest: Author has declared no competing Interest exists.

References

1. ADB. SECTOR ASSESSMENT (SUMMARY): IRRIGATION Nepal: Community Irrigation Project Sector 2013.
2. Biswas AK (1989) Irrigation in Nepal: Opportunities and Constraints. J Irrig Drain Eng 115: 1051-1064.
3. Angew Chemie (1967) Int Ed 6: 951-952.
4. Galore BAN (2004) Changing trade scenario in agriculture and its implications for the indian economy.
5. Gale F, Hansen J, Jewison M (2015) China's Growing Demand for Agricultural Imports. USDA-ERS Econ Inf Bull.
6. FARMER MANAGED IRRIGATION SYSTEMS IN NEPAL AT THE CROSSROAD ** Prachanda Pradhan* 2000.
7. Pradhan P, Belbase M (2018) Institutional Reforms in Irrigation Sector for Sustainable Agriculture Water Management including Water Users Associations in Nepal. Hydro Nepal J Water, Energy Environ 23: 58-70.
8. Khadka DB (2021) Performance Evaluation of Hydropower plants of Nepal using Multi Criteria Decision Analysis : Review Study.
9. Adhikari C, Adhikary B, Rajbhandari NP, Hooper M, Upreti HK, et al. (1999) Wheat and Rice in the Mid-Hills of Nepal: A Benchmark Report CIMMYT on Farm Resources and Production Practices in Kavre District.
10. DoWRI (2019) Irrigation Master Plan. Dep Water Resour Irrig.
11. Parajuli J (2018) Analyzing Challenges of Irrigation Systems in Nepal from Socio-Ecological System Framework.
12. Chaudhary D (2018) AGRICULTURAL POLICIES AND RURAL DEVELOPMENT IN NEPAL: AN OVERVIEW Chaudhary, Deepak 3. Res Nepal J Dev Stud.
13. Gebul MA (2021) Trend, status, and challenges of irrigation development in Ethiopia—A review. Sustain.
14. Paper R (2008) Climate change and its impact on nepalese agriculture.
15. Pangali Sharma TP, Zhang J, Koju UA, Zhang S, Bai Y, et al. (2019) Review of flood disaster studies in Nepal: A remote sensing perspective. Int J Disaster Risk Reduct 34: 18-27.
16. Tripathi BP, Bhandari HN, Ladha JK (2019) Rice Strategy for Nepal. Acta Sci Agric 3: 171-180.
17. Deshar BD (2013) An Overview of Agricultural Degradation in Nepal. Glob J Econ Soc Dev 3: 1-20.
18. Gairhe samaya, Karki T, Namdev U, Sapkota S (2019) (PDF) Trend analysis of wheat area, production and productivity in Nepal: An overview. Policy-analysis-of-agricultural-productivity-food-security-and-commercialization-in-Nepal.