RESTORING COMPETITIVE AND COMMERCIAL AGRICULTURE IN RIVER BASIN OF NEPAL WITH FOCUS ON DARAUDI RIVER BASIN, GORKHA

S. Pokhrel*
Agriculture and Forestry University, Rampur, Chitwan, Nepal

*Corresponding author: surojpokhrel@yahoo.com
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ABSTRACT

Daraudi river basin and sub-basins consisted of numerous fertile tars, phants and upland (24173 ha) supplying foods in settlements and neighboring cities. Agriculture in this area is no more attractive because of small size land/farm holdings (0.25ha/HH), subsistence farming, high production cost, higher agricultural risks, low productivity and low income. The aim of this research was to investigate the way of economic resilience by means of commercial agriculture, agricultural risk reduction, implementation of agriculture engineering and linking farm activities to services. Relevant literatures were reviewed, field verification and interactions were made in different rural municipalities/municipalities in the year 2021. The study found that the maize and millet in upland and rice-based cropping system in irrigated land are common in water shed and basin area. Cattle (35,709), buffalo (27,921), goat (82,358), sheep (6,806), pigs (5,430) and chicken (1,92,584) are major livestock kept. The area is in balance only on cereals (17,864 mt) and spices (735.3 mt/year) and deficit in all other foods. Land fallow (27.0%) is increasing because of youth out migration (0.72 persons/HH/year). The respondents demanded establishment of larger farm sizes (82.2%) from land pulling, farmers/entrepreneurs organizations development (54.4%), identification of profitable and competitive value chain for commercial production (74.4%), promote agriculture engineering activities (94.4%), minimization of agricultural and environmental risks (57.8%) and creation of local off farm employment (56.7%). They also suggested to have a commercial farm operation guideline (46.7%), linking all farm operation to services (55.6%, linking neighboring small producers with commercial farm for services (52.2%) and establishing a strong collaboration among all stakeholders in an integrated approach (42.2% respondents). It is recommended to address the demand of the respondents for restoring the competitive and commercial agriculture in river basin of Daraudi river. Similar recommendation may apply to other river basins in Nepal.

Keywords: Collaboration, commodity, engineering, profitable

INTRODUCTION

Nepal is highly vulnerable to a number of disasters for example: earthquakes, floods, landslides, fires, epidemics, avalanches, windstorms, hailstorms, lightning, glacier lake outburst floods, droughts and dangerous weather events (Subedi & Poudyal Chhetri, 2019). Gorkha is one of the eastern districts of Gandaki Province, highly vulnerable on these short of disasters. Risk Nexus, 2014 recommended having a comprehensive approach to reduce the vulnerability of households to other more frequent hazards, such as landslides, floods, droughts, pests and diseases in Gorkha. The disaster resilient agriculture that covers structural improvement of farm structures like storage house, livestock and poultry shades, threshing floors, irrigation canals, pump houses and other, adoption of technologies that control soil erosion and conserve the soil carbon and moisture is equally important for disaster risk reduction. For this, a diversified agriculture production system that includes an ecological design, adaption of traditional landscape technology and conservation agriculture is recommended (Lengnick, 2018). Improved institutional and technical capacities of farmer groups, adoption of improved agricultural technologies/practices, livestock, soil and plant health management, increased access of farmers to input and output market and improved rehabilitation work in agriculture infrastructures are important (ADRA, 2017). Modern technology and strategic communication/ risk mapping/satellite mapping/earth observation are also important tools and techniques in reducing the disaster risks; and in life-saving (Subedi & Poudyal Chhetri, 2019). Mass awareness, community resilience, effective disaster governance, institutional efficiency in all phases (preparedness, response recovery and reconstruction) is necessary. The government, local people, INGOs, NGO all should address the disaster specific needs, priorities and plans in reducing the risk and also disaster management perspective (Chhetri, 2018).

Gorkha is one of the districts in Gandaki Province as per the new federal structure. It with an appropriate area of about 3610 Km^2 (270 15'-27o 45' N to 840 27'-85o 85' E longitudes) lies in the western part

of Nepal bordering with Dhading district to the East; Tanahun and Chitwan districts to the South; Tanahun, Lamjung and Manang districts to the West and Tibet (China) to the North. Gorkha is geographically diverse district. The climate ranges from southern tropical belt (300-1,000 masl) to subtropical, temperate, alpine and Himalayan (3,000 to 6,400 masl) belt in the north. Total area in the district is 3,610 km² with the population density of 69.86/km². Gorkha has a population of 252,201 with 119,811 (47.5%) male and 132,39 (52.5%) females. The annual population change over a period of ten years (2011 – 2021) is in decreasing trend (-0.69%) (CBS, 2021). Of these, Khas are largest ethnic group (38%) followed by Pahadi Brahmin (21%) and Gurungs 16%. Magar, Tamang, Ghale, Muslim, Newar, Kumal, Chepang, and Dalits are other ethnic caste, communities in the district (CBS, 2011). Women population (52.5%) is larger than male (47.5%) (CBS, 2021). Population in northern rural municipalities is sparsely distributed. Where, it is dense in the southern part of the district.

Gorkha is politically divided in to 11 rural municipalities/municipalities. Chun Numbri, Dharche, Barpak Sulikot and Ajirkot rural municipalities lie in the north, Siranchok, Gorkha and Palungtar in south-west and Arughat, Bhimsen, Sahid Lakhan and Gandaki in south-east areas. Northern Gorkha is most vulnerable zone for food insecurity (AKC Gorkha, 2019). It is recommended to maintain at least 50% food deficit as buffer stocks in northern municipalities for the emergencies in Gorkha (Pokhrel, 2020a). Each nation and the municipalities have their own land and food policy and regulation in the world (Sushma, 2018) based on which they maintain food security. But it is lacking in the northern municipalities in Gorkha. Countries like US, China and Brazil, either have larger land masses or they are part of bigger economic unions with as cope for the expansion of cultivated areas and herd/farm sizes for the commercial production (Sushma, 2018). However, in developing countries, commercialization is possible only with prioritized commodity with their raised productivity through improved management practices (Pokhrel, 2020b) and other institutional services. Many other countries having higher animal and crop yield like USA and India have developed, popularized and scaled up the high-tech initiative for higher and quality yields (World Bank Group, 2020). There is a need to replace the domination of supply driven agriculture extension approaches by the demand-driven services (Birner & Anderson, 2007). However, the extension services in Nepal are based more on donor's interest and less concerned on the demand of farmers that is needed to be properly addressed (Dhital, 2017).

The cultivated area in Gorkha is 48,182 ha, of which 30.6% is irrigated. Beside crop production, livestock is another strong business (AKC Gorkha, 2019; MoALD, 2019). Daraudi is the major river related to socio-economics of Gorkha. Daraudi water shed covers Ajirkot, Siranchok, Barpak Sulikot, Gorkha, Bhimsen, Sahid Lakhan and Palungtar municipalities. It covers about 60% area of Ajirkot and Siranchok; 100% area of Barpak Sulikot and Gorkha and about 40% area of Bhimsen, Sahid Lakhan and Palungtar municipalities. Agriculture is the major occupation in Daraudi water shed. However, food availability and consumption vary in different municipalities (Pokhrel, 2021).

Daraudi basin is one of the fertile areas supplying rice to the major settlements in Gorkha and Gandaki province. Where, the farmer's access on improved inputs (seeds, breeds, fertilizers, crop varieties and technologies) is very low. Important agriculture infrastructures are limited. The irrigation structures are temporary/muddy and insufficient. Market infrastructures e.g. collection centre, storage, processing and packaging structures are lacking and the market information are limited. The basin and the sub-basin areas are not inter linked by the transportation means hindering farm input supply and collection of the agri-products. Narrow terraces are hindering farm mechanization. Soil erosion and land degradation is very high because of flood inundation and river encroachment. Water stresses, and other agricultural risks of pest epidemics, pesticide residue, etc are very high. All these resulted high production cost, low productivity, low income and dis-motivation to agriculture sector. The overall objective of the program was to investigate the economic resilience of the residents in Daraudi basin and sub-basins.

In this situation, it is utmost necessary to find the agriculture strategies for the economic resilience of the residents in Daraudi basin and sub-basins for local employment and income generation, agricultural risk reduction, effective implementation of agriculture engineering and link farm activities to research, extension, training/education, marketing and financial services.

MATERIALS AND METHODS

Relevant literatures from the journals, books, newsletters, web portals were reviewed. Secondary data on cultivated areas, livestock population, crop and animal production were collected from Agriculture Knowledge Centre (AKC), Gorkha and Ministry of Agriculture and Livestock Development (MoALD). The information on food sufficiency and food policy were taken from the publication of Nepal Public Policy Review, Rural Municipality, Nayapatrika daily, Journal of Environment Sciences, www.futuredirections and The World Bank Group. The literature regarding the National Population and Housing Census were reviewed from the publication of Central Bureau of Statistics and literature on disaster risk reduction from Adventist Development and Relief Agency International Nepal, Centre for Disaster Management, Sustainable Agriculture Research and Education, Risk Nexus and www.intechopen.com. However, the literatures on agriculture extension system and food policy were reviewed from the publications available from International Food Policy Research Institute and Research Gate. The maps on Daraudi tributaries, water shed and basin and land use were down loaded from Google map and Land use map.

Low farm income with lower profit made farmers dis-motivation on agriculture in Daraudi water shed areas. Where, the rate of land fallow seemed very high and higher rate of poverty and out migration. Moreover, Daraudi basin represents the majority river water shed and river basin in Nepal. These were the major reasons on selecting Daraudi basin for the study.

A technical check lists was prepared for a consultative meeting holed in Kathmandu in 5 October 2021. A total of 9 experts (agriculture 2, politician 1, agri-economist 1, sociology 1, engineering 2, environment 1 and zoologist 1) were participated in the meeting. They were origin of Gorkha or had experiences of working in Gorkha district. The check list was prepared to understand the possible way out for the economic resilience of Daraudi water shed and river basin.

Farmer's field visits and interactions were made along the road/trail sides for easy access of the information. Farmers field on the road/trail side in all the municipalities in Daraudi basin and sub-basins were visited and verified in 3rd week of October 2021. Interactions were made with 10-15 key informant farmers and political leaders as a focal group discussion (FGD) in each municipality (total 90). The frequencies of responses received based on the ranking from each respondent were counted. The percentage of the response was calculated and tabulated. Qualitative information collected from interactions and field visit were synthesized and the results were presented.

RESULTS AND DISCUSSION

Socio-economic and land use assessment of the Daraudi water shed/basin

Daraudi water shed consisted with the water shed of its numerous tributaries. The water shed covers about 30% geographical area of the district. Total area of Daraudi water shed is estimated to be 60,610 ha. The cultivated area is 20,656 ha. There are more than two dozen major tars and phants along the basin and sub-basins. There are 31 major settlements in Daraudi water shed discussed below. Among the cultivated land 57.3% are rain fed with maize and millet base cropping pattern. Rest of the irrigated land is rice-based farming mainly in river basins. Nearly 90% of the rural population in Darudi basin depends on agriculture. However, they are self-sufficient only on cereals and spices and rest other foods are in deficit. It is because of small size land holdings, subsistence farming, high production cost and higher environmental and marketing risks.

Daraudi river and its tributaries

The length of the Daraudi river from the Baluwa in north to Ramsahaghat in the south, where it meets Marsangdi river is estimated 117.91km. There are a number of tributaries (total 37, major 16) they fed Daraudi with in this length. The total length of these tributaries is estimated 260.46 km. Thus, a total of 378.37km long basin and the sub-basin have consisted along the length of Daraudi river and its tributaries (Table 1, Figure1)**.**

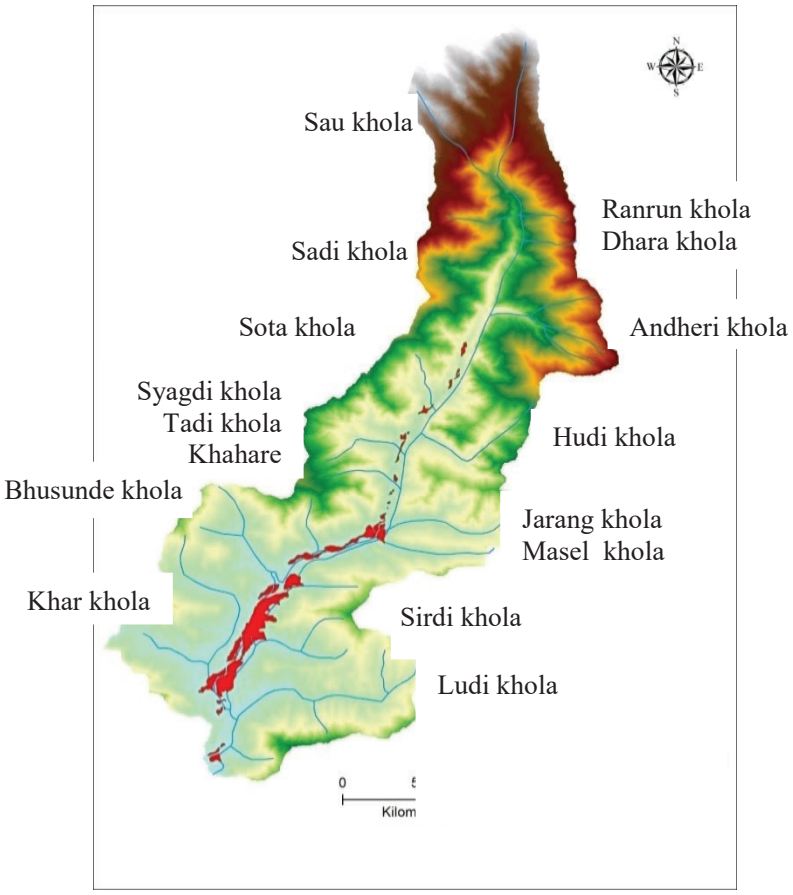

Figure1. Daraudi river and its major tributaries (Source: Google map, 2021).

Table 1. Daraudi river and its tributaries in different municipalities' in Gorkha

Municipality	Daraudi and tributaries
Ajirkot	Fagsin, Jholi, Adheri, Sota, Sandi, Sadhi and Jhyalla khola
Barpak Sulikot	Daraudi, Pau, Ghatte, Omra, Skall, Hudi and Stul khola
Siranchok	Daraudi, Bhusunde, Langdi, Ludi, Khahare and Sangdi
Gorkha	Daraudi, Sirdi, Ludi, Karne, Jyadul, Gangate, Beni, Khalte and Bhalu khola
Sahid Lakhan	Daraudi, Ludi, Jyadul, Bahi & Jugdi khola
Bhimsen	Masel & Jarang khola
Palungtar	Kharkhola, Sera Khola

Daraudi water shed area

The water shed of Daraudi river covers about the 60% areas of in Ajirkot and Siranchok; 100% in Barpak Sulikot & Gorkha and 40% in Bhimsen, Sahid Lakhan and Palungtar municipalities. Total water shed area of Daraudi river is estimated to be 60,610 ha (Figure1).

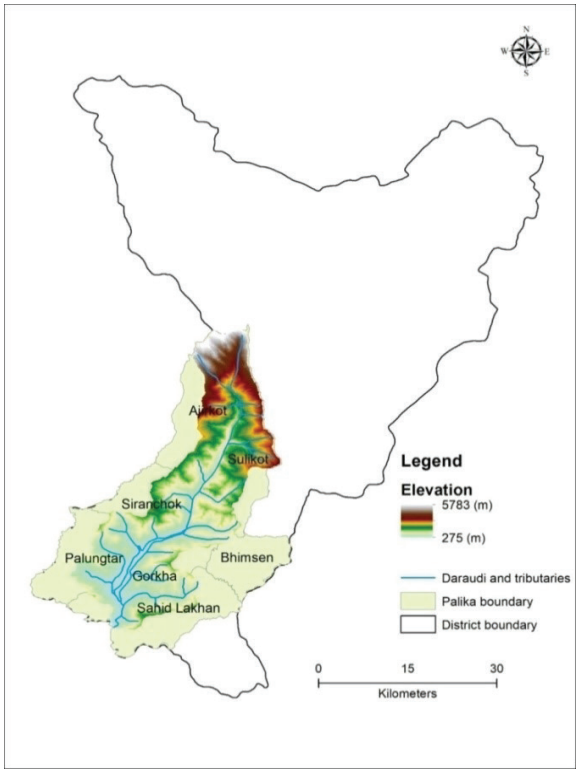

Figure 2. Daraudi water shed area in Gorkha

(Source: Google map, 2021).

Major phants/tars of Daraudi basin and sub-basins

The tars and phants along the basin and sub-basins of Daraudi river are: Baluwa, Jhyalla phant, Muchchowktar, Sourpani phant, Jhewa phant, Chanaute, Phinamtar, Joubari, Langdi phant, Argul phant, Mahatar, Talkhola, Barabise phant, Nayasangu, Sikhar phant, Gangatekhola phant, Nibel phant, Ulte phant, Hundikhola phant, Japhati phant, Kumaltari phant, Lankuribot, Jarebar phant, Putalikhola, Barapirke, Chhepetar, Bhusunde phant, Harkambesi phant, Kundurtar, Abuwa phant and Tinkilo phant. They are fertile land for the agriculture point of view (Figure 3).

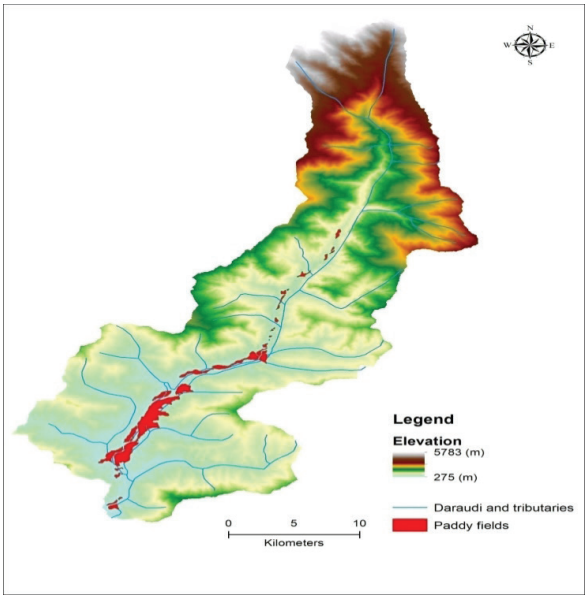

Figure 3. Location of different tars adjoining to Daraudi river

(Source: Google map, 2021)**.**

Population and settlements

It is estimated that the 80% total population of Gorkha are the residence of Daraudi water shed). The total population is 1,86,159 with about 52.5% women. Annual population change in these areas is about -0.69% (2011 → 2021). It is estimated that the 60% population of Ajirkot and Siranchok; 100% Barpak Sulikot and Gorkha and 40% in Bhimsen, Sahid Lakhan and Palungtar municipalities are the residence of Daraudi water shed (Table 2).

Table 2. Total population in Daraudi water shed area, 2078

Municipality	Population Census		
	001-05-28	2011-06-22	2021-11-11
Ajirkot	17,737	15,602	13,002
Barpak Sulikot	27,415	25,399	23,222
Siranchok	28,010	23,666	19,829
Gorkha	44,433	50,684	53,285
Bhimsen	24,885	22,053	17,118
Sahid Lakhan	31,649	27,555	22,429
Palungtar	42,117	38,244	37,274
Total	**216,246**	**203,203**	**186,159**

Source: CBS, 2021

There are 31 major settlements in Daraudi water shed. They are: Baluwa, Dhodeni, Jhyallaphant, Muchchwoktar, Chanaute, Phinamtar, Arghul, Bhaluswanra, Khahare, Mahatar, Ulte, Nibel, Sikhar, Nayasangu, Jarebot, Chorkate, Bhusunde, Chhoprak, Chhepetar, Satdobato, Lamabagar, 10 kilo,11 kilo, 12 kilo and 13 kilo, Syaulibazar, Kundurtar, Abauwa, 3 kilo, Majhuwadeurali and Aanbookhaireni.

Land use pattern in Daraudi water shed

Total area of Daraudi water shed is estimated to be 60,610 ha. Forest occupies the largest area (46.90%) which is 28425 ha, followed by agriculture 24173 ha (39.88%). A considerable area (3733 ha) of grass land, shrub land (1488) and barren land (1247 ha) are there suitable for pasture. The snow area and glaciers (1264 ha) at the north feds water to Daraudi river (Table 3, Figure 4).

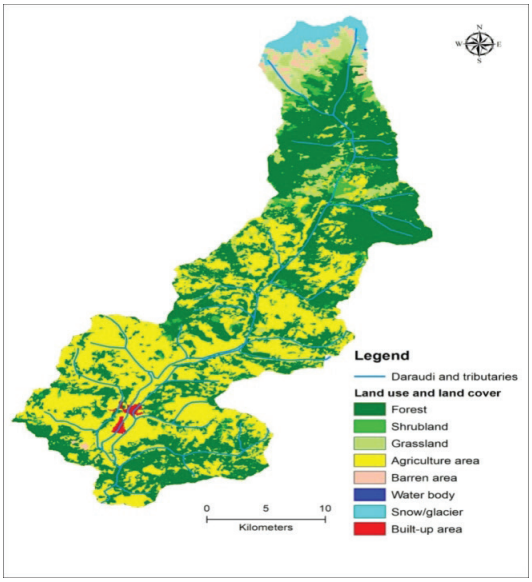

Figure 4. Land use map of Daraudi river basin

Source: Google map, 2021

Table 3. Daraudi river basin, land use pattern

Land use	Ha	Percentage
Forest	28425	46.90
Shrub land	1488	2.46
Grass land	3733	6.16
Agriculture area	24173	39.88
Barren area	1247	2.06
Water body	3	0.00
Snow/glacier	1264	2.09
Built-up area	277	0.46
Total	**60,610**	**100.00**

Source: Land use map (2010)

Agriculture and livelihood in Daraudi Basin

About 60% cultivated area and livestock population in Ajirkot and Siranchok; 100% in Barpak Sulikot and Gorkha; 40% in Bhimsen, Sahid Lakhan and Palungtar municipalities falls under Daraudi water shed. The cultivated land in Daraudi water shed is estimated to be 20,656 ha. Only the 40% of which are irrigated and majority (60%) are under rain fed agriculture (Table 4).

Table 4. Agriculture land use and livestock population

Municipality	Agriculture land			Livestock population					
	Irrigated	Rainfed	Total	Buffalo	Cattle	Goat	Sheep	Poultry	Pigs
Ajirkot	1306	1037	2343	5132	5914	14595	3144	28944	600
Siranchok	773	1243	2016	5393	5566	11008	0	24780	1224
Barpak Sulikot	1635	3272	4907	1500	7150	20890	3662	45700	1500
Gorkha	3242	2282	5524	5357	7322	15580	0	42240	809
Bhimsen	492	679	1189	3933	2929	6496	0	16136	292
Sahid Lakhan	388	693	1082	3934	3054	7441	0	17752	721
Palungtar	980	2615	3595	2672	3774	6348	0	17032	284
Total	**8,816**	**11,821**	**20,656**	**27,921**	**35,709**	**82,358**	**6,806**	**1,92,584**	**5,430**

Source: AKC Gorkha (2019); MoALD (2019)

Cropping pattern, crop varieties and technology adopted

Major cropping pattern found in Khet (irrigated) land are:

- Rice-wheat-fallow
- Rice-fallow-fallow
- Rice-fallow-maize
- Rice-potato-maize

Where, the major cropping patterns found in Bari (upland) are:

- Maize-millet-fallow
- Maize-black gram-fallow
- Upland paddy-black gram

However, the land fallow is increasing rapidly (27.0% at present). Crop varieties using are all most local varieties with the farmers saved seeds. The seed replacement rate (SRR) is less than 10% for the major cereals and the production technology is traditional with low level of farm inputs use.

Food sufficiency

Food balance in Daraudi water shed seems negative in all kind of food except cereals and spices. Cereal is balance by 17,864mt and spices by 735.3mt/year. Pulses (2636.6mt), Vegetable (6490.7mt), potato (13284mt), fruits (1760.9mt), meat (1751.9mt), milk (6634.4 mt) and egg (6707.7 pieces/year) production are in deficit and sugar, oil/fat, fish and honey production are almost negligible (Table 5).

Table 5. Food (milled/table, mt) sufficiency status in Daraudi Basin and sub-basins

Commodity	B.Sulikot	Ajirkot	Siranchok	Gorkha	Palungtar	Bhimsen	S.Lakhan	Total
Cereals	2699.8	6000.1	3424.9	707.3	7491.3	-660.7	-1798.9	17,864
Pulses	-543.4	219.8	-430.8	-792.8	10.7	-467.7	-632.4	-2636.6
Vegetables	-1071	-603.2	-1892	-2504	-422.4	228.5	-226.1	-6490.7
Potato/tubers	-2085	-165.1	97.8	-3939	-2876	-1902	-2414.3	-13284
Fruits	-524.1	-378.7	-551.3	-391.8	208.8	-603.2	479.4	-1760.9
Spices	172.7	267.2	266.7	-81	-2.1	70.1	41.7	735.3
Sugar	-406.4	-249.6	-378.7	-810.9	-611.9	-352.8	-440.9	-3251.2
Oilseed/Ghee	-400.8	-239.4	-359.9	-698	-536.7	-285.8	-424	-2944.6
Honey	-12.3	-5.6	-11.4	-24.3	-18.6	-10.8	-13.6	-96.6
Meat	-132.6	-28.7	-178.3	-586.6	-410.9	-182	-232.8	-1751.9
Milk (Catt,Buff)	-1325	678.2	-71.6	-2643	-1835	-1127	-310.5	-6634.4
Eggs (000)	-762.2	-266.9	-723	-2011	-1411	-655.5	-878.6	-6707.7

Note: Information on tea, coffee, fish, wool and lokta is not available **Source:** Pokhrel (2021)

Ajirkot is self-sufficient on cereals, pulses, spices and milk but seemed deficit on meat and eggs and seriously deficit on vegetable, potato and fruits production. Barpak Sulikot is self- sufficient on cereals and spices and serious deficit on pulses, table vegetable, potato and fruits with moderately deficit on meat, milk, oil/fat and eggs production. Siranchok is in balance and self-sufficient on cereals, potato and spices but the pulses, vegetable, fruits and meat seemed seriously deficit. Bhimsen is in balance for vegetables and spices but seemed seriously deficit on cereals, pulses, potato, fruits, meat and milk production. Sahid Lakhan is self-sufficient on fruits and spices, seriously deficit on cereals, pulses, vegetables and potato, meat and milk and deficit on eggs. Gorkha is in balance and self-sufficient on cereals, seriously deficit in pulses, vegetables, potato, fruits, spices, sugar, oilseed/ghee, honey, meat, milk and egg production. Palungtar is self-sufficient in cereals, pulses and fruits, deficit on vegetable, potato, spices, meat, eggs and milk production (Pokhrel, 2021)

Employment and income generation

Nearly 90% of the rural population in Darudi basin depends on agriculture. Three quarters of population cannot meet their subsistence requirements from the production of their small size land holdings. Farms sizes are decreasing per HHs and 70% of the households own less than 0.25 ha/HH cultivated land. Off farm income sources are still very limited. Large-scale circular migration of labor force has become an important strategy of survival for the poor majority (one third of the working population or an annual average of 0.72 persons per households). Other indications for mass poverty in Gorkha and Daraudi basin are more than 41% illiterate. The infant mortality is considerably higher than the national average (RM's Profile, 2020).

Demanded activities for competitive and commercial agriculture

The most demanded activities of the local farmers in Daraudi basin and sub-basins are the competitiveness and commercial agriculture, agriculture engineering that includes river training, soil erosion control, terrace improvement, rehabilitation of farmers managed irrigation systems (FMIS), other farm structures, collection and storage centers, marketing infra-structure and custom hiring centers (94.4% respondents) (Table 6).

Table 6. Activities for competitive and commercial agriculture in Daraudi basin

Activities	Farmers % (N=60)	Local leader (N=30)	Total (N=90)
Establishing farmers/entrepreneurs' organizations	51.7(31)	60(18)	54.4(49)
Environmental risk reduction	58.3(35)	56.7(17)	57.8(52)
High value commodity/sub-sector/value chain identification, production	70.0(42)	83.3(25)	74.4(67)
Preparation and execution of a commercial farm operation guideline	51.7 (31)	36.7(11)	46.7(42)
Agriculture engineering	91.7(55)	100.0(30)	94.4(85)
Land pulling & establishing larger production farms	80.0(48)	86.7(26)	82.2(74)
Agriculture research	35.0(21)	36.7(11)	35.6(32)
Extension services	48.3(29)	60.0(18)	52.2(47)
Financial services	66.7(40)	63.3(19)	65.6(59)
High value seed production	41.7(25)	43.3(13)	42.2(38)
Linking farm activities to services & markets	58.3(35)	50.0(15)	55.6(50)
Linking commercial farm to services for the neighboring small holding farms	48.3(29)	60.0(18)	52.2(47)
Off farm employment	48.3(29)	73.3(22)	56.7(51)
Collaboration	45.0(27)	36.7(11)	42.2(38)

Note: Figures in parentheses resemble respondent numbers

Other activities demanded were: land pulling and establishing larger production farms, high value commodity/sub-sector/value chain identification and cultivation/rearing, environmental risk reduction, establishing farmers/entrepreneurs organizations, high value seed production, agriculture research, extension services, financial services, linking all farm activities to services and markets, linking small producer neighboring farm to commercial farm for services, off farm employment for non-agricultural manpower, preparation and execution of a commercial farm operation guideline and establish strong collaboration among all the stakeholders (Table 6).

Establishing farmers/entrepreneurs' organizations

Identification and demarcation of program areas, clustering the area in to basin and sub-basins and organizing farmer's groups/cooperatives/association and entrepreneurs' organizations are the basic step to implement the commercial, cost effective and competitive agriculture activities in Daraudi water shed and the basin. Further, it is necessary to capacitate local communities, the users' groups, cooperatives and farmers/ entrepreneurs' organizations and follow the participatory approach.

Environmental risk reduction and GESI

Daraudi basin is facing serious climate induced disasters. Flooding, sand inundation and land cutting are very common. Soil erosion is severe with frequent water stresses. Levels of pest and disease epidemics are high. Pesticide residue and poisoning are occasionally reported. Disturbance on agro-ecosystem services, especially natural control, pollination, symbiosis and nutrient cycling are higher. There is an immense need to implement the environment risk reduction programs that include climate smart/resilient agriculture and organic/integrated pest management (IPM) to optimize the production and reduce health hazards. Environmental protection, agro ecosystem conservation, Disaster Risk Reduction (DRR), Climate Change Adaptation (CCA) and green technologies must be in priority. Gender equity and social inclusion (GESI) mainstreaming should be emphasized; hence most farm activities are carried out by women but most house hold decisions are made by the men.

Commodity/sub-sector/value chain identification

There is a major role of Daraudi basin on food security in Gorkha district and Gandaki province. However, there is a need of replacing subsistence farming, lower productivity and low income for economic resilience. For this, the value chain/sub-sector identification is the pre-requisite step. Selection of the value chain/sub-sector must be by the user's organization, based on commercialization, competitiveness and income generation. Rice based farming, followed by wheat or high value potato, mushroom, onion, garlic and green vegetables can be the alternatives. Moreover, organic vegetable farming, livestock farming with larger dairy farms of buffalo and cattle, poultry and ducks, goat and pigs, fishery and beekeeping, pasture development are other potential agriculture businesses. Agro-forestry with medicinal herbs, high value trees and kabuliati ban (leasehold forestry) are also equally important for the local level employment generation and economic resilience.

Agriculture engineering

Agriculture engineering is the most important function demanded for the agriculture development in Daraudi basin and sub-basins. River training is most important immense need to control of soil erosion and river training for the protection of fertile agricultural land. That prevents sand inundation. Smaller terraces are the obstacle for the farm mechanization and need to improve them. It can help to establish larger farm sizes, land pulling and reduction of the farming cost. Connection of the sub-basins to Daraudi basin and finally the road head is needed for the use of farm mechanization and transportation of input and farm products. A graveled road network is demanded for this. Sand inundation by the flood in majority basin areas demanded soil improvement. Once the terrace is improved it also needs top soil management and organic amendment. The farmers managed irrigation systems (FMISs) throughout the river basin and sub-basins are of muddy structured and have weak intake and distribution systems that need to reconstruct/improve them. Additional irrigation system, lift & solar irrigation, micro irrigation may be needed. Increasing the water efficiency is equally important. Establishing custom hiring centre equipped with farm machineries and equipment's including dryers for chaite rice, tractors, levelers, threshers, cleaners and graders are necessary. Collection centers, cold storage/chain and transportation vehicles support for perishables and other farm structures like distribution canals, shade houses, threshing floor, culverts and grain storage are necessary to enhance the production efficiency.

Land pulling, establishing larger production farms and benefits sharing

Land pulling from the smallholders is necessary for terrace improvement, farm mechanization and establishing larger production farms. Formulation of working guideline/s for land use and benefit-sharing is necessary by the farmers/entrepreneurs' organizations. Based on which the decision on the farming modality either communal, community, co-operative, private, company farming can be established, run and benefit-sharing. Land pulling can be on the basis of land banking and use for production plan as per the contract farming, community farming, cooperative farming, corporate farming, etc. The large sizes is estimated to be at least 200ha of rice-based farming, 1,00,000 plants of fruits, 500 cattle/buffalo, 2000 goats/pigs, 100ha of vegetable, medicinal herbs or other farming, 50,000 poultry birds, 1000 bee colonies. Initially, at least one commercial farm, profitable with healthy production established in each ward and will increase the number in a settlement as necessary. Land required to the program should be taken from the farmers for 15-20 years in a reasonable lease (lease amount should not be less than income from existing /traditional farming). In the end, the program should be handed over, as normal operating condition, to the landowners without any cost. Landowner farmers should be directly involved as member of the operating committee, organization, cooperative, group, company or firm or may participate as the shareholder for the operation of the farm on the basis of profit sharing. The operating committee may hire agricultural graduates, commercial farmers, corporate business persons and the expert/s for the operation of the enterprise/farm.

Agriculture research

Participatory agriculture research focus on varietal screening of rice, wheat, potato, onion, garlic and vegetables in Daraudi basin is necessary. Breed selection of major livestock like goat, pig, chicken, etc is also needed. Local-level technology verification and agriculture risk reduction against market functionaries, biological and climate-related disasters are also important.

Extension services

There should have a provision of at least one community agriculture and livestock service center in each municipality in Daraudi basin and sub-basins. Farmer's training and skill development should be on FFS mode. These service centers shall be operated by the municipalities. They should promote DRR, climate smart/resilience agriculture for maximizing the quality production. They should be involved on the regulatory services for the seed quality, fertilizer, manure, pesticide, feed and quality of the veterinary medicine. They can support on diagnostic and treatment services on plant pests, nutrients deficiency, stresses and animal diseases. Another major function can be input management like seeds, fertilizer, manure, pesticide, equipment, feeds, etc. Breed improvement of cattle, buffalo, goat, sheep, -pigs and chicken is equally important. They can provide technical services for agriculture and livestock production, beekeeping, fishery and so on. They can promote services from linking farms to markets and agro-industries, facilitate land banking, contract farming, community farming, cooperative farming and can generate baseline data and make periodic progress reports.

High value commodity production

Once the high-value commodity/sub-sector/value chain is identified on the basis of commercialization, competitiveness and income generation, commercial production of which is necessary. All the services like research, extension, education, financial and marketing should concentrate on the production and marketing of these commodities. High-value seed production of rice, wheat, potato, maize and forage is a potential commodity for an example. The establishment of farmer's seed company/industry, implementation of the seed certification scheme, seed production, collection, processing, packaging, storage and marketing can be the step ahead in a value chain. Establishment of a seed bank can help on the local level in-situ conservation of the landraces and crop improvement.

Linking farm activities to services

It is necessary to integrate agriculture research, education/training (employee and farmers), extension services, and financial services, input management and marketing services with the farm activities. The input management and marketing of agro-products of the surrounding farmers shall be through these commercial farms. This program will establish different processing units to process the primary product in different value chains and link to outside markets.

Off-farm employment generation

Once the land pulling and establishment of the larger farms a number of smallholding landowner will be out of the on-farm activities. They should organize a number of cooperatives, firms or the companies to carry out the potential off-farm businesses. The first priority shall be collection, processing and marketing of the agro-products, the second may be on local level services.

Financial services

A number of financial services may necessary while implementing these activities. Provision of bank soft loan special focus to infrastructure (engineering) is necessary. Subsidy supports special focus to infrastructure (engineering) and agriculture production may necessary. Microfinance special focus on agriculture production shall be an effective tool for in time purchasing the needed inputs and crop/seed/farm structure/livestock insurances for agriculture risk reduction.

Collaboration and synergy

All the related existing ongoing projects and program like Prime Minister Agriculture Modernization Program (PMAMP) shall be tie up with this program. The program shall be coordinated from Ministry of Finance with Ministry of Agriculture and Livestock, Ministry of Water resources, Ministry of Physical Infrastructure and Ministry of Forest and Environment at Federal level and concern ministries in Province level. The concern Local Governments in the program area shall be responsible for the execution of the program activities. Collaboration with financial institutions and insurance companies, collaboration with Food Corporation, agro-industries and market centers for the collection and marketing of agro-products and collaboration with input suppliers are equally important. It shows that collaboration with all stakeholders, public, private and community is necessary.

CONCLUSION

Daraudi river basin and the sub-basins along its tributaries consisted with numerous fertile tars, phants and bari land (24173 ha) with 42.7% irrigated area. Total population in this basin command is 186,159, majority (90%) depending on agriculture. Maize and millet in bari and rice based cropping system are common. Cattle (35,709), buffalo (27,921), goat (82,358), sheep (6,806) and pigs are major livestock (5,430) and chicken (1,92,584) in this area. However, the small size land/farm holdings, subsistence farming, high production cost and higher environmental and marketing risks pushed them to the verge of deficiency of foods except for cereals and spices. Land fragmentation is increasing (0.25 ha/HH). There are limited employment opportunities at the local level, that increases the youth out migration (0.72 persons/HH/year) and land fallow is increasing rapidly (27.0%). Thus, there is an immense need to create local level employment targeted to youth, establish economically viable enterprises and income generation for livelihood and economic resilience. For this, the following activities are recommended which are demanded by the residents of Daraudi basin and sub-basins:

- Land pulling and establishment of larger farm sizes for making the agriculture business profitable, competitive and commercial one.
- Establishing farmers/entrepreneurs' organizations for the ownership and raising strong voices for their right.
- Prepare guideline for the operation of the commercial farm in a community/communal/corporate/ company/ firm basis
- Participatory identification of the commodity/sub-sector/value chain, high-value food and seed production on the basis of profitability, competitiveness and commercial scale of production.
- Promote agriculture engineering activities for river training, soil erosion control, terrace improvement, rehabilitation of farmers managed irrigation systems (FMIS), construction of other farm infrastructure like collection, storage, marketing and custom hiring centers, etc.
- Link farm operation to services on a participatory basis like agriculture research, extension services, financial services, input and market functions.
- Link the commercial farm to neighboring small producers for the services like agriculture research, extension services, financial services, input distribution and collection and marketing of the farm products.
- Agricultural and environmental risk reduction through implementation of climate-resilient agriculture and infrastructures, inputs and support services and improved marketing facilities for optimizing the quality and healthy production.
- Create local level off farm employment through establishing agro processing industries and also from non-agricultural sector like services and manufacturing for the man power not engaged on agriculture production farms.
- Establish strong collaboration among all stakeholders including private, community, cooperative, I/ NGO, financial and public sector in a integrated approach.

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REFERENCES

ADRA (Adventist Development and Relief Agency International). (2017). Food security enhancement and agricultural resilience for the earthquake affected rural nepalese farmers (FOSTER). http://adranepal.org/?p=1131

AKC (Agriculture Knowledge Centre) Gorkha. (2019). Annual report, 2075/076.

Birner, R. & Anderson, J. (2007). How to make agriculture extension demand driven? The case of India's agriculture extension policy. Discussion paper 00729. Washing D.C. International Food Policy Research Institute.

Chhetri, M.B.P. (2018). Socio-economic impacts and lessons learned from the Gorkha, Nepal Earthquake 2015. Nepal Centre for Disaster Management. Presented Paper at the IDMC 22-24 October. Gumushane, Turkey; 2018

Dhital, P.R. (2017). Agricultural extension in Nepal: experiences and issue. https://www.researchgate.net/publication/319617467

Google map. (2021). https://www.google.com/l?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjG1MPkqLLzAhW1yTgGHSQXBI0QFnoECAgQAQ&url=Land use map (2010). https://www.google.com/search?q=Land+use+map,+2010&tbm=isch&chips=q:land+use+map+2010,online_chips:nepal:0DGVzvmkKbs%3D&hl=en&sa=X&ved=2ahUKEwiC7uDdzNjzAhUNeysKHS00CugQ4lYoA3oECAEQFg&biw=1686&bih=780

Lengnick, L. (2018). Introduction to Climate Resilience in Agriculture. SARE (Sustainable Agriculture Research and Education). 28 p.

MoALD (Ministry of Agriculture and Livestock Development). (2019). Statistical information on Nepalese Agriculture 2018/019. Agri-Business Promotion and Statistics Division, Singha Durbar, Kathmandu, Nepal.

CBS (Central Bureau of Statistics Nepal). (2022). Gorkha District in Nepal. http://www.citypopulation.de/php/nepal-mun-admin.php?adm1id=36

CBS (Central Bureau of Statistics Nepal). (2011). National population and housing census, 2011.

Pokhrel, S. (2020a). Krishima aatma nirvar hune dabab (In Nepali). Nayapatrika daily (Aartha),13 April, 2020.P10.

Pokhrel, S. (2020b). Impact of covid-19 lockdown on agriculture and developing strategies against it for sustained food production and supply: special focus to Nepal. *Journal of Environment Sciences*, 6(1), 1-11.

Pokhrel, S. (2021). Post disaster agricultural strategies for food sufficiency and economic resilience: special focus on Gorkha, Nepal in Relation to Barpak Earthquake, 2015. *Nepal Public Policy Review*, 1:109–137.

Risk Nexus. (2014). Urgent case for recovery: what we can learn from the August Karnali River floods in Nepal. https://reliefweb.int/sites/reliefweb.int/files/resources/risk-nexus-karnali-river-floods-nepal-july-2015.pdf

Subedi, S. & Poudyal Chhetri, M.B. (2019). Impacts of the 2015 gorkha earthquake: lessons learnt from Nepal.

The World Bank Group. (2020). Agriculture and Food. https://www.worldbank.org/en/topic/agriculture/overview