Importance of world high altitude Jumli Marshi rice with cultivation practices

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ABSTRACT

Geographically, Jumla is a Himalayan mountainous region located in the Karnali Province of Nepal. It has a beautiful landscape with abundant plant and animal species and is rich in biodiversity. Jumli Marshi has been cultivated since prehistoric times. Marshi has nutritional, religious, and cultural significance. The Chumchaur of Jumla, a place where rice cultivation is carried out at the highest elevation (3050 m) of the world. In the past, the field at the bank of the Tila river was filled with Jumli Marshi rice; however, its cultivation is currently decreasing day by day due to low productivity and blast susceptibility. Farmers prefer to grow improved varieties such as Chandannath-1 and Chandannath-3 rather than Marshi. Jumla's peasant worked very hard to produce this local variety and the role of women in producing this variety is crucial. The cultivation practice for Marshi production is unique compared with other rice production practices in Nepal. Due to its richness in fiber (2.01 %), proteins (9.86 %), minerals such as 0.57 mg/100 g iron, 66.70 mg/100 g calcium, and 57.54 mg/100 g phosphorous, and low carbohydrates (72.74 %), it is regarded as suitable food for diabetes patients. Furthermore, it contains more nutrients than other rice varieties commonly grown in Nepal. Therefore, conservation and cultivation of Jumli Marshi should be promoted to preserve local diversity and contribute to sustainable local food production systems, agro-ecotourism, and crop improvement programs.

1. Introduction

Jumli Marshi rice (Oryza sativa var. japonica) is an indigenous and important cold tolerant summer field crop in Jumla (Paudel, 2011; Acharya, 2019). It is desirable for its peculiar taste followed by its red color inside. The presence of cold-tolerant genes helps to resist the cold environment of Jumla (Poudel 2005). Moreover, cold-tolerance in Jumli Marshi is not restricted to only one gene, but involves several underlying molecular pathways that are activated by cold (Chawade et al., 2013). Rice is cultivated in irrigated areas (khet) and the cropping pattern followed in Jumla is rice-wheat/barley/potato. Its cultivation is done at the highest elevation of the world around 3050 m above sea level in Chumchaur of Jumla (JADP 2014). Jumli Marshi is a staple food crop in Jumla district and its demand in other areas is pretty high mainly because of its good taste and organic by nature. It is widely used for making rice, porridge, Sel roti (sweet rice bread), and beverages. It is rich in nutritional value compared to other rice varieties such as Khumal (Joshi et al., 2020a). There are two types of Jumli Marshi rice, one with black husks and the other with white husks, but the inner portion of both varieties is red. Rice cultivation in Jumla is highly labor-intensive and is quite different from that in other parts of Nepal. Peasants face many hardships in producing this local variety. The cultivation and harvest of rice seems to be a kind of festive for farmers in this area. At present, the local Jumli Marshi has taken great height in the Nepalese market because of its high nutritional value, organic nature, and better flavor. However, farmers are unable to produce adequate Jumli Marshi to meet market demand due to decreasing productivity, climate change and blast disease.

The International Rice Research Institute (IRRI) has certified “Jumli Marshi” (paddy cultivated in the hilly district of Jumla) as one of the cold tolerant varieties of paddy worldwide (Poudel 2005; Lindfors et al., 2015; Khatri et al., 2019). Various landraces that differed in phenotype and well adapted to extreme high-altitude environment was recognized in Jumla (2200-3000masl) as Jumli Marshi (Bajracharya et al., 2006). Jumli Marshi has medicinal value (Acharya 2019). The major unique

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traits of Jumli Marshi are early maturation, colored grains, sticky rice, cold tolerance, and taste (Bajracharya et al., 2006; Chaulagain and Saund 2017; Acharya 2019).

Chumchaur is the highest altitude in the world located in the Patarasi Rural Municipality of Jumla where rice is grown (JADP, 2014). As per the local person of Chumchaur, Kaliman Mahatara rice cultivation in Chumchaur formally started in 2021 B.S after the registration of land in 2019 B.S. The rice seedlings were taken from the field of Chandannath temple (locally called Shera Jieulo) and were cultivated in Chumchaur land. With the passage of time, the cultivation of Jumli Marshi on that land remains interrupted because of a lack of irrigation facilities and labor shortage. At the same time, people earn more by harvesting medicinal plants Cordyceps sinensis (Yarshagumba) than by planting rice, and the rice field remains barren. However, people now have a keen interest in cultivating local Marshi due to high market demand. Agriculture is major source of livelihood for the rural mountainous people. The flow of national and international tourists is high in Jumla due to the accessibility of road transportation and airways. While experiencing the flavor of organic local Jumli Marshi rice is always the best choice for visitors, the popularity of Jumli Marshi hit the market high.

Conserving these local landraces, it will promote agro-tourism and homestays (local houses that are designed for visitors and serve local food) which subsequently contribute to the livelihood of rural people through a better income. Due to organic apple production, availability of the world’s highest-altitude rice cultivation area and availability of the Nepal Agriculture Research Council station numerous people visit Jumla. This will promote internal as well as external tourism in Jumla and contribute to agro-tourism as many homestays are already established in the area of Chumchaur, where rice is produced at the highest altitude of the world.

This review paper was prepared from all available resources collected from peer-reviewed research papers. For gray literature, all available information was retrieved from the NARC website, newspaper reports, and from the Agriculture Service Centre Jumla and personal communication with retailers, lead farmers and other stakeholders who were directly involved in different sectors of Jumli rice. Cultivation practices were recorded during direct field visits to Jumla where Jumli Marshi was cultivated. All collected information was systematically presented with different headings and subheadings.

2. Origin of Jumli Marshi

Jumli Marshi is believed to have originated 550 years ago. The exact origin of Jumli Marshi remains controversial. Different ideas have been extracted from the literature. The majority of the local people believed that Chandannath Baba first found this wild landrace at the bank of the Tila river and later domesticated this variety. As per the local inhabitants, there was a lake in the Jumla valley, and the wild landrace was around the periphery of the valley. Later, Chandannath baba drained water from the valley and domesticated Jumli Marshi rice around the area (Joshi 2018).

After developing the Jumli Marshi, Chandannath baba taught Lachalkriti Paikalo, a genius person of that era to cultivate the seed of the Marshi (Nepali Rabi 2020). As per the conversation with the old person of Tatopani Rural Municipality Mr. Shivala Khatri, the Lachalkriti Paikalo was a more intelligent and farsighted person in that area. Therefore, Chandannath Baba taught him the cultivation practices of Marshi and he grew the Marshi seeds in the Litakot village of Jumla (currently Tatopani Rural Municipality ward number 3) by managing irrigation sources. For the first time, formal cultivation of Jumli Marshi was conducted in his own village in the Lachu field. As per chairperson of the Tatopani rural municipality Mr. Nawaraj Neupane, they celebrate rice plantation day in the Lachu field every year from the Municipality. As per him, the municipality allocates certain funds and the aim of celebrating rice plantation day is not only to plant Marshi seedlings in the field but also to maintain the conservation and sustainable use of the historically significant rice field. Some believed that Jumli Marshi was imported from Kumau of India which is connected to border of Sinja valley. Others believe that Chandannath Baba imported seeds from Kashmir and started cultivation in Jumla. However, others believed that it was introduced from Jammu and Kashmir of India to Jumla (Rana et al., 2006; Acharya 2019).

3. Historical and cultural values of Jumli Marshi

During the Rana regime, Jumli Marshi was sent to the Rana and Royal families from Jumla to Kathmandu through the post office (Singh 2019). The post office was specially established to transport Jumli Marshi from Jumla to Kathmandu. The regular consumption of Jumli Marshi by Rana and the Royal Family since prehistorical times indicates the significant value of these local varieties. Jumla sent Marshi rice as substitute for tax to Kathmandu. As per the historian Rajaram Subedi, Chandannath Baba in the late 1450 BS during the victory of Jumla state, welcomed King Baliraj Shahi by putting the tika of Kalimarsi rice. This reflects the religious and cultural significance of Jumli Marshi rice. The consumption of Jumli Marshi is limited to the local area of Jumla. The commercial business of Marshi has not yet been promoted; however, some of the local shops of Jumla sell Marshi to visitors to Jumla. Currently, eating Jumli Marshi rice is prestigious. Jumli Marshi rice is especially cooked while welcoming guests and during the festive season. The popularity of Marshi peaked when the famous political leaders Puspa Kamal Dahal and K.P. Oli consumed the rice of Jumli Marshi. After this, the demand for Jumli Marshi was high in the market and people had an interest in this local variety.

4. Nutritional value of Jumli Marshi and other rice varieties

Jumli Marshi is rich in minerals, proteins, micronutrients, and antioxidants compared with other commonly grown rice varieties in Nepal (Joshi et al., 2020a, 2020b). It has a higher amount of protein, flavonoids, antioxidants, and polyphenols than Boraang, Saali, and Khumal rice varieties as shown in Figure 1. antioxidants are free radical scavengers. They prevent damage by neutralizing free radicals and other unstable molecules in the body. Furthermore, the concentrations of minerals such as calcium, phosphorus, and iron were also higher in Jumli Marshi than in other rice varieties. Because of the high fiber and low carbohydrate content in Jumli Marshi, it is expected to be beneficial for patients with obesity and diabetes (Venn and Mann 2004). This rice is also regularly consumed with lentils, vegetables, and pickles or “Dal Vat”. It is also used in making Nepal traditional bread also known popularly as “Sel Roti”. Jumli Marshi is tasty, delicious, and nutritious when consumed with milk and ghee. People prefer to eat Jumli Marshi rather than Khumal, Saali and Boraang rice because of its high nutritional value.

5. Cultivation practices

5.1. Method of preparing sprouted seeds for nursery bed

Jumla has its own rice seasonal calendar; therefore, practices adopted for rice cultivation in Jumla differ from those in other parts of Nepal. On Chaitra 12 (25th March) the rice seeds are washed 2 to 3 times with cold water to remove the damaged and unfilled seeds, and then the seeds are allowed to remain in the water for 4 days. After 4 days of dipping in water on Chaitra 16 (29th April), the water is drained out and for a few hours, the seeds are allowed to sun dry in the early morning. The seeds are then kept in the kitchen and wrap up with the jute bags or radi (a cloth made especially in the kitchen for 4 days). Each day in the morning and evening, slight watering is done on seeds for 4 days. Keeping in the kitchen provides a warm temperature for the rapid sprouting of seeds. On the same day, the Jumli people had a tradition of making beaten rice from those dipped seeds and this beaten rice would be used by the women during
rice seedling transplanting time. On Chaitra 20 (2nd April) the sprouted seeds are broadcasted in wet nursery beds. After broadcasting seeds in the nursery bed, women celebrate the happy eve by playing deuda (enjoy singing local songs) with their close sisters and daughters and eating delicious food at the home. This day provides opportunities for women to meet and share their happiness. The 12th, 16th and 20th days of Chaitra are locally called baruwa, soruwa and biusa, respectively, in Jumla. Figure 2 shows the sprouted seeds of Marshi.

5.2. Nursery bed preparation

The beds (locally known as Berna) are prepared by ploughing followed by four to five planking. While preparing nursery beds adequate amounts of organic manure such as farmyard manure (gothemal) is applied in the nursery field. Then the sprouted seeds are broadcasted in the nursery bed. Broadcasting activities are performed by men while transporting manure is done by women. Water about 5–7 cm is maintained in the nursery bed throughout seedling growing period. Generally, within a period of 30–45 days, the seedlings are ready for transplantation in Jumla. 30–45 days is the minimum period between broadcasting of seeds in nursery beds and rice transplanting. In the Nepali new year, 1st Baishak, the nursery bed is worshiped.

5.3. Field preparation

The field should be well prepared before rice transplantation. Usually, 2 ploughings are required, former is done after harvesting the barley, and later before rice transplanting. First ploughing helps to reduce the incidence of weeds in rice and makes soil manipulation easy. After the second ploughing, planking is performed to level the field and even break the clods. Bunds are prepared while making the field. Men perform activities such as ploughing and puddling while seedling pulling, transporting them to rice fields and transplanting is done by females. The participation of both men and women is equal during rice plantations. Figure 3 shows the sprouting seedlings of Jumli Marshi.

5.4. Transplanting of seedlings

Generally, 1-month old seedlings are transplanted the fields. However, fluctuations can occur within a few days. The seedlings are pulled just one day before planting or early morning on the plantation day. Subsequently, they are transplanted to the main field. Transplantation is performed solely by the females.

The transplantation date varies among the households in the village. This allows for the exchange of labor between the villagers. In Jumla, transplantation starts from the 1st week of Jestha to the 3rd week of Jestha.

5.5. Intercropping in the bunds

A week after rice transplanting, the soybean is intercropped in the bunds. The intercropping of legumes helps fix free atmospheric nitrogen and increase rice productivity. Traditional cultivar of soybeans such as Muse and Bikase are used in the bunds of rice fields. Thus, farmers sow soybeans around the bunds of the rice fields. This method has been used for a long time. Soybeans are harvested at the time of the rice harvest. An additional yield is obtained from these bunds.

5.6. Irrigation

Rice cultivation in Jumla depends on the rainfed system. After transplanting rice, the field is irrigated continuously and at least 7–10 cm of water is maintained in the field. Farmers are more conscious of irrigating fields at critical stages such as tilling and flowering for higher yields. Canal irrigation is done to irrigate the fields. The irrigation is stopped almost one month before harvesting i.e. at the end of August.
Rice requires two-three weeding during the growing season. The weeding is performed manually by the women using their hands. The incidence of weed is high in rice fields; therefore, it requires more than two weedicings to obtain a better yield. The initial weeding is done just 15 days after transplanting and the second weeding is performed 30 days after transplanting. Usually, females pluck the weed in the field using their hands and males used a wooden plank to remove floating weeds from the field. Men and women play an equal role in the weeding of rice but plucking weeds in flooded soil with the naked hand is difficult. Being organic by default there is no use of pesticides to kill weeds in Jumla. Farming practices are labor-intensive however, they are organic and contribute to sustainable farming systems. The adoption of gender and eco-friendly agricultural tools needs to be promoted to reduce intensive labor costs and for easy cultivation.

5.8. Insect pest and blast disease

As a mountainous region, the impacts of climate change are clearly visible in Jumla and its neighboring districts. Hailstorms during harvesting cause lodging and shattering of the panicle as the variety is tall which directly reduces the grain yield. The incidence of pest and blast diseases is quite high in Jumla in the present situation compared to the past. According to the Jumla Agriculture development plan (JADP 2014) the infestation of rice borers and bugs in rice is 15 percent. Furthermore, Jumli Marshi is susceptible to blast disease therefore farmers are reluctant to cultivate Jumli Marshi. Therefore, the total area and productivity of this local variety are decrease every year. Nevertheless, the Nepal Agriculture Research Council has developed two improved dwarf varieties Chandannath-1 and Chandannath-3 by incorporating cold resistance genes and both varieties are resistant to blast disease. Chandannath-1 is red in color whereas Chandannath-3 is a white. After the development of this improved blast resistance variety, the majority of farmers prefer to cultivate this variety than the local one. Therefore, the conservation and sustainable use of Jumli Marshi is at risk and if immediate measures are not addressed well, we cannot say that it will be extinct. Similarly, the occurrence of different pests is also higher in rice fields than in the past.

5.9. Harvesting

Rice takes more than 6 months to complete its one-season growing period. The rice transplanted in the Jestha month is ready to be harvested in Kartik. During this 6-month period, the rice is fully mature and ready for harvesting. During this rice harvesting period, all farmers are busy with their farm activities and had a hectic schedule. There are more positive vibes in farmers as they welcome hard work in their homes. Therefore, it is somewhat like a festive vibe. Generally, the harvesting of Jumli Marshi lasts from first week to second week of October. Harvesting of new rice starts on Ghaasthapana by offering puja (water-filled holy earthen pot is kept offering warmly to female deity during nine days of Durga Puja) (Paudel 2011). The harvesting operation is performed by both men and women. Tillers are cut 5–7 cm above ground level. After harvesting, the harvested tillers are threshed manually and these activities are performed by males. Finally, the remaining threshed straw portion is transported in the individual house and at the end, bullocks are used for complete exhaustion of the grains from the panicle. Figures 5 and 6 shows the mature field and manual harvesting of Marshi rice and left for the field for sundry.

5.10. Yield

The average yield of Jumli Marshi is 1.7 t/ha which is low as compared to a national average yield of rice i.e 3.79 t/ha. Disease pest and blast disease incidence, low use of manure, climate change impacts, quality seed, and labor unavailability, and poor post-harvest technology are the major reasons for the low productivity of Jumli Marshi.

5.11. Storage

Grains are stored in jute bags, wooden granaries, earthen pots, or trenches of around $6 \times 4 \times 3$. Inside the house, such trenches are dug, and bedding materials are placed on the pit's surface to keep the rice from damage. Cow dung, clay soil, and litter plaster are glued on the mouths of pits that are capped with a wooden plank roof. Tadis patra (Abis spectabilis) leaves are bedded at the bottom of the pit and in the sidewall. These pits are filled with rice grains, which are extracted as needed for consumption. Large farmers are the only ones who use pits to store their grains. Rice is stored in small local containers and consumed by small farmers. Marginal farmers store rice in small local containers and consume it quickly, but major farmers keep rice for up to 2–3 years and have a better social status for older rice. Even after 2–3 years in temperate settings, the taste of rice is said to become more delicious. The process of sun drying Marshi seed for safe storage is shown in Figure 7.
6. Problems associated with Jumli Marshi rice

6.1. Climate change

Rice production in Jumla is affected by intermittent rainfall and fluctuating temperatures (Sapkota et al., 2010). Frequent rainfall and hailstones may cause grain shedding problems. Occasionally, during the reproductive stages of grain filling and maturity cold injury may occur (Sapkota et al., 2010). As per the information gained from the senior citizens of Jumla, the level of water in the Tila river and its tributary during the rice-growing season has receded in recent years due to climate change which might be a sign of danger in proper cultivation of this variety and the problem in rice cultivation might occur due to shortage of labor and inputs (Paudel 2011).

6.2. Low productivity and introduction of improved varieties

Jumli Marshi yields up to around 1.79 t/ha which is 50% lower as compared to national average rice productivity of Nepal i.e., 3.76 t/ha. Improved varieties such as Chandannath-1, Chandannath-3, and Chinese hybrid rice yields higher than those of Jumli Marshi. The introduction of hybrid rice and improved varieties such as Chinese hybrids, Chandannath-1, and Chandannath-3 with better productivity and more resistance to blast disease poses a threat to local Jumla Marshi rice. Chandannath-3 is becoming more popular in Jumla and its yield potential is 50% of that of Jumli Marshi.

6.3. Insect pest susceptible

The major problem is that the Jumli Marshi rice variety is very susceptible to blast which causes a huge loss in yield. This blast has led to a state of extinction. A confirmed outbreak of disease caused by a fungus (Magnaporthe grisea) dried the plant.

6.4. Area decline

Fertile land is being converted into concrete land after opening Surkhet-Jumla road thereby decreasing the land area for cultivation. Cultivation of this rice is limited to small areas in specific locations such as Sinja and along the Tila river of the Jumla district. Because of problems linked to insect invasions and climate change that have brought torrential rains, the cultivated area is slowly declining. Improved cultivars have replaced some areas of the Jumli Marshi.

6.5. Traditional cultivation practices

Due to lack of knowledge on a quality seeds people use the same seed from time to time for cultivation which reduces yields. It is often hard to retain the product for seed purposes. For a long time, farmers either used their own saved seeds or exchanged them with each other, and the continuous use of the same seeds resulted in seed deterioration. Despite being aware of low productivity, farmers have grown it for personal consumption.

7. Future prospects of Jumli Marshi

7.1. Higher price

The potential of local rice (Jumli Marshi) is unable to fulfill the population demands of Jumla (Sapkota et al., 2010). The price of this rice is skyrocketing and is expected to be approximately $3 USD per Kilogram in Nepal. This is because of a surge in demand followed by a low yield of this rice. As the demand for Marshi rice is increasing, people have started ordering Marshi from Jumla. As stated by Shyam Thapa (vendor at Agri Center New Baneshwor), Marshi's demand has increased tremendously. He has reported Marshi as “lacking”. As stated by Thapa, Marshi sold at Rs 250 per kg. The Agri Center sold 100 kg of Marshi rice and brought another 500 kg of Marshi rice. This means “five hundred kilos have been retained after selling one hundred kilos of Marshi”. Thapa also said, “now we will pack them and bring them to the market”. Marshi is sold a by entrepreneurs in 2 kg bags. The demand for Marshi in groceries and departmental stores has escalated rapidly. Led to the discovery of a new life the disappearance of Marshi. Jumli Marshi is a challenging cheap and tasty variety of Mansuli, Masino and Basmati rice. The demand for jumla rice and other commodities (Jumla walnut, local beans, apples, and barley flour) is increasing day by day. As stated by Merchants, prices are rising because of high demand. Even supermarkets are also ordering large quantities of the Jumli Marshi. According to the traders, there are not enough supplies of Marshi as demanded due to low and limited production.
7.2. Foreign export and value addition

The demand for Jumli Marshi is increasing day by day nationally due to its high nutritional value and sweetish taste. Jumli Marshi is exported as organic rice in Canada, Japan, European countries. More than 50 countries have used Jumli Marshi rice for research breeding and production purpose (Joshi et al., 2014). Its demand is mounting day by day among the urban dwellers. Product diversification such as branding of the product, packing, and organic certification. Not only grain it can be preceding to flour, biscuits, etc. for value addition.

More than 50 countries have used Jumli Maarsee rice in research, breeding, and production (Joshi et al., 2014).

7.3. Jumli Marshi “as a source of valuable genetic materials”

In Jumli Marshi the global transcriptional response to cold stress (+4 °C) was studied and significantly differently expressed 4636 genes were identified within 24 h of cold stress. Comparative analysis in Jumli Marshi rice resulted in the identification of 2101 genes (DE) which are differentially expressed only in chilling tolerant Jumli Marshi rice. Jumli Marshi variety has a higher tolerance to cold stress as compared to IR64. Jumli Marshi showed a higher Fv/Fm ratio for three weeks old seedlings during three days in cold (4 °C). Photosystem II was less affected by the treatment in Jumli Marshi than in IR64 seedlings, and consequently, was able to cope with the stress in a better way (Khatri et al., 2019).

Comparative global gene expression profiling analysis of the chilling tolerant varieties Sijung and Jumli Marshi (spp. Japonica) during the phase of early chilling stage identifies Jumli Marshi as ‘the protection of chloroplast translation and detoxification is prioritized’. The comparative global gene expression profiling analysis also shows that during cold stress various cellular components play their distinct roles. Several orgLoc genes from the nucleus, plasma membrane, endoplasmic reticulum, and other components were distinctively expressed in Jumli Marshi (Chawade et al., 2013). At this altitude Jumli Marshi can be grown while maintaining productivity corresponding to 60% of the average Nepal rice productivity per hectare which indicates that Jumli Marshi is indeed chilling tolerant. Chilling tolerant Nepalese rice cultivars i.e Manjushree-2 and Khumal-8 were produced using Jumli Marshi as one of the parents (Gautam and Shrestha 2012). It was also used as a parental donor in Madagascar for the development of upland chilling tolerant rice FOFIFA-172 (Rabin et al., 2010).

7.4. Promote agro-ecotourism

Chumchaur valley (a place where Jumli Marshi is cultivated at the highest altitude of the world) is a popular spot for agro-eco tourism. Jumli Marshi acts as a destination medium to allow visitors to come and be in contact with the inhabitants of small, rural village and to explore the traditional way of agriculture which is still existing in that community. This plays an important role in promoting conservation of agrobiodiversity on-farm, sustainable utilization of agricultural genetic resources since the 1990s, utilization of the diversified resources, promotion of different sets of varieties, improve access to various sets of planting materials, achieving long-term food and nutrition security. It motivates and encourages farming communities to establish their crops in an eco-friendly manner and to conserve the biodiversity of farms (Dangol and Ranabhat 2007).

There is no doubt that agro eco-tourism influenced by Jumli Marshi will promote heritage sites visit, trekking, mountainaineering expedition, furious jungle safaris, and adventure looking after the economy and employment for the country. They need to encourage early maturing (160 days) rice varieties like Jumli Marshi to increase rice production in high altitude zones. It also has a lot of quality features and is a good source of germplasm for future varietal development. At the same time, it is in the process of disappearance and insufficient work has been done for its improvement and diversification. Hence, such a typical traditional organic rice production system in the highest altitude of the world needs a bit more emphasis from all institutional authorities (GOs, NGOs, INGOs) which are concerned to protect it for the upcoming future generations. More than 50 countries have used Jumli Marshi rice for research breeding and production purpose (Chaulagain and Saund. 2017). Its demand is mounting day by day among the urban dwellers. Product diversification such as branding of a product, packing, and organic certification should be taken into account.

7.5. Community seed bank

In the Jumla district, few associations supported by local farmers are creating a seed bank whose objective is to hold on to and promote local seeds. It’s an ex-situ conservation of local germplasm or genetic materials for future use.

8. Gender roles, biodiversity and Marshi production

Women driven agriculture is more dominant in the Himalayan parts of Nepal as many youths are migrating abroad in search of jobs. Women, including indigenous and local women, are holders and keepers of biodiversity conservation knowledge and practices (Khadka and Verma 2012). In their everyday life, they take an active part in the sustainable use of resources and the management of their natural environment: as food providers and food producers, rural women are directly linked to the management of germplasm for food and agriculture; women are leading collectives and informal gatherings such as saving groups which are powerful tools for biodiversity conservation; they are also a critical part of the solutions to halt biodiversity loss, with their specialized and unique knowledge, different perspectives and priorities, as well as their capacity in managing natural resources, and adapting along with innovating in the face of change; and many indigenous and grassroots women are also active as environmental defenders. Hence, the role of women in the Jumli Marshi rice production is crucial. Out of all the activities, weeding is highly labor intensive and takes a lot of time. Depending upon the emergence of weeds, two to three times weeding is done to have a good harvest. As per the Kamala Gautam one of the farmers of Gau-tambada opine that “We have to spend a hard time while weeding the Marshi rice fields, dipping the hand into the flooded soil removes the tip portion of nails and it’s difficult to eat with the hand for few days”. Development and adoption of the gender friendly agriculture tools is urgent to reduce intensive labor and the available time will be used by the women for other household chores such as kitchen gardening which helps to conserve biodiversity and ensure regular supply of fresh foods. They are the one who put their best efforts to produce Marshi using indigenous skills, knowledge, and capacity which is contributing to the protection of local landraces and biodiversity. The indigenous practice of sowing soybean in the bunds of rice field helps to the nitrogen fixation process, increase rice yield and contribute to conserve biodiversity.

9. Conclusion

Jumli Marshi is a native japonica rice landrace cultivated since ancient times at the highest altitude in the world at Chumchaur (3050 masl), Jumla in Nepal. It’s unique rice landraces possess some unique features, cold-tolerant genes, and are highly nutritious along with medicinal values. Because of the cold-tolerant gene, it’s demand increase in crop improvements programs. Low productivity, disease susceptibility are major problems so breeding efforts to make resistance to disease and highly productive. Until now, Nepal fails to get the patent right of Jumli Marshi while on the other side its demand is high, but productivity is decreasing due to more disease and pest incidence following the climate change impacts. The majority of farmers prefer the cultivation of the hybrid variety of rice, showing reluctance towards the cultivation of the local Marshi. If the trend of cultivating Marshi continues on the same decreasing way, we may loss our local diversity and identity of local people of Jumla. Besides organic Apple, Jumla is popular for its Marshi...
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All authors were agreed to publish this paper.

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