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Sustaining Rice Farming in Kashmir Valley: Challenges and Opportunities

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ABSTRACT

Rice productivity in the state is high with 3.1 t/ha compared with the national average productivity of about 2.0 t/ha, although with the passage of time the area under rice in Jammu & Kashmir state is continuously decreasing because of climatic and diversification forces. Food grain deficiency in the state has already touched to 40% and majorly in rice which is bound to grow in future. Despite of decreasing land area under paddy in the state, productivity trend is showing an upward trend which is due to the efforts of the Research & Development institutes for breeding of better seed varieties and other technological interventions. Economic viability and social acceptability apart from environmental acclimatization plays an important role for any crop to sustain. The aromatic local land races yielding lesser than the main varieties such as Jhelum and SR-1 were found to make higher net returns due to relatively higher prices for the grain/rice. A lot of scope exists for curtailing the costs on part of labour if mechanization can be introduced in paddy cultivation as it entails the major share (60%) of Cost. In order to sustain the viability of paddy framing and to compete with the imported rice, more emphasis needs to be given on better seeds through seed replacement; resource use efficiency for optimizing yields and reducing costs; bridging the yield gap through scientific and extension interventions.

Keywords: Productivity, rice, Kashmir, economic viability

Rice production in the Jammu and Kashmir (J&K) is predominantly a mono cropped activity with a very high consumption and most important staple food than other states of India. The area under the rice is distributed by both the regions in which about 40% of production is from Jammu division while as 60% from Kashmir division (Statistical Digest, 2015-16). Rice play an important role in the livelihood of the people in the state, although the area under the crop is very small as compared to other states of the India with only 0.30 m hectare area, but at the same time plays an important role in the state economy (Economic Survey, 2016). Rice productivity in the state is high with 3.1 t/ha compared with the national average productivity of about 2.0 t/ha, although with the passage of time the area under rice in J&K is continuously decreasing (CSAP of J&K, 2015; Kaloo *et al.* 2014)). Rice in Jammu and Kashmir is grown only once in a year because of the extreme climatic conditions, further it can be said that the diversity in the agro-climate which when coupled with farmers preferences give rise to wide range of grain preferences from bold, coarse grains in temperature regions to fine, aromatic and basmati in subtropical areas. At the same time the Jammu region represents almost all the zones ranging from the subtropical one

to mid hills extending to high hills constituting the temperature zone. Basmati rice is grown on more than 32,000 ha (2014-15) area of Jammu division particularly in the R.S Pora belt which is famous in the world for its famous high aroma. The business from basmati rice annually fetches more than forty five (45) crores of rupees (Kaloo & Choure, 2015).

Thus the cultivation of the rice in this region offers a great potential for its improvement, but at the same time there is a much worry to the State of J&K in terms of food grain deficiency as it has already touched to 40% (CSAP of J&K, 2015) and is anticipated to aggravate in the future. The deficiency in food grains (rice) can be revealed from the fact that the production of rice in J&K is only seven lakh metric tons whereas the demand is eleven lakh metric tonnes hence there is a miss match in demand and supply which ultimately results in the inflation. The deficiency in the food grains has been attributed to rampant conversion of agricultural land and depleting efficiency of the land, as in Kashmir alone more than ten thousand hectares of agricultural land of the net sown area has been converted for commercial and other purposes (Mukeet Akmali, 2017). However, the net production of rice is increasing despite the land diversion as the methods of cultivation of rice has been shifted from traditional practices to the modern ones coupled with introduction of improved varieties (Wani *et al.* 2013; Statistical Digest, 2015-16).

MATERIALS AND METHODS

The present research was based on secondary as well as primary data. The primary data were collected from farmers through field survey conducted in 2015 and 2016 with the help of pre-tested schedule. However, the secondary data were collected from both published (Statistical Digest and Economic Survey) and online sources. The collected data were put to analysis for evaluating the economics of rice production in Kashmir valley and to compare it with rice production at national level. The cost concept used for analysis is described as below:

Cost A_1: All actual expenses in cash and kind incurred in production by owner farmer

Cost A_2: Cost A_1+ rent paid for leased-in land

Cost B_1: Cost A_1 + Interest on value of owned capital assets (excluding land)

Cost B_2: Cost B_1 + Rental value of owned land (net of land revenue)

Cost C_1: Cost B_1 + Imputed value of Family Labour

Cost C_2: Cost B_2 + Imputed value of family Labour

Cost C_3: Cost C_2 + 10% of Cost C2 on account of managerial functions performed by farmer

RESULTS AND DISCUSSION

Production scenario and demand-supply management

With the passage of the time, the production of rice in Jammu and Kashmir has increased (Fig. 1) from 391 thousand tonnes in 1999-2000 to 647 thousand tonnes in 2015–16. But at the same time, there is a continuous decline in the area under rice in Jammu and Kashmir. At present, state has a total area of 304500 ha under rice, out of which 47% is in Kashmir Division and 53% in Jammu Division while as 60% of total production is contributed by Kashmir Division and rest 40% by Jammu Division with total production of 646600 tonnes of rice (Statistical Digest, 2015-16).

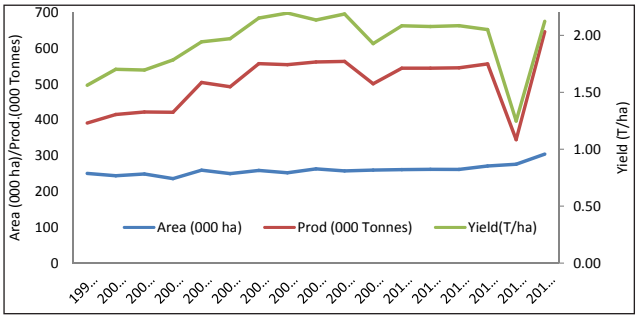

Fig. 1: Area, production and productivity trend of rice in J&K state

Out of all twenty two (22) districts in Jammu and Kashmir, only twelve (12) districts are suitable for rice cultivation, although it is cultivated throughout state, except two districts of Ladakh region. Kashmir Division has relatively higher productivity levels (40 t/ha) than the Jammu Division (3.2 t/ha). Within Kashmir Division, the districts like Anantnag, Shopian, Bandipore and Kupwara fall under high productivity areas with more than 4.5 t/ha while as rest fall under 3.5 to 4 t/ha. On the other hand, the

most of the district in Jammu Division fall under the productivity range of 2-2.5 t/ha with some districts like Reasi, Rajouri and Kishtwar as low as 1.0-1.5 t/ha. Jammu district has the maximum acreage under rice (79153 hectare) with production of 202567 tonnes and contributes about 21 per cent of total rice production of state. In Kashmir Division, Kupwara, Anantnag and Budgam are the major producing districts with more than one lakh tonne production.

Despite of decreasing land area under paddy in the state, productivity trend is showing an upward trend, except for the year 2014 where it has dipped due to loss of crop to floods. Gains in productivity levels over the time may be attributed to the efforts of the R&D institutes, particularly, SKUAST-K for breeding of better seed varieties and other technological interventions; role of State Agriculture Department for various crop specific programs and schemes; and irrigation infrastructure in terms of canals and field channels by Command Area Development Department, besides the farmers own efforts.

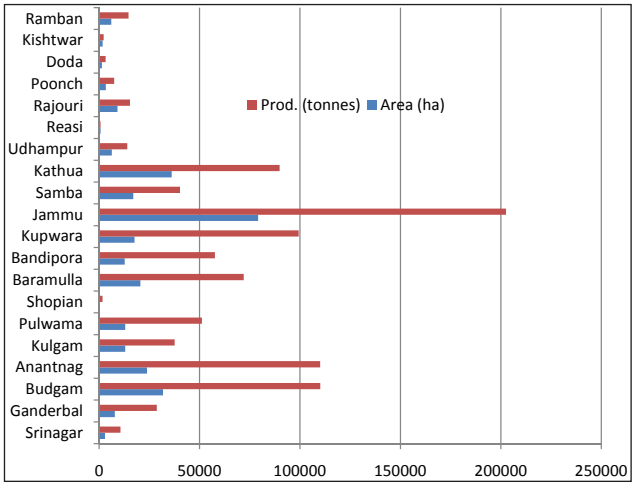

Fig. 2: Area and Production across districts of state (2015-16)

With each passing year, the gap between the demand and domestic production of rice in the state widens and resulting in increased dependence on import of rice with growing rationed population. The Fig. 3 depicts the increasing trend over the last decade for import and off-take of rice through Public Distribution System of the State. Apart from the Public Distribution System (PDS), significant populace also purchases from the open market (Statistical Digest, 2015-16).

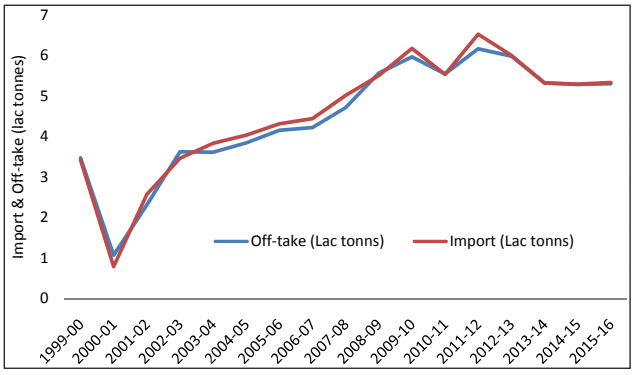

Fig. 3: Import and off-take of rice from public distribution system in J&K state

Genetic diversity and erosion

The state is rich in rice culture from the ancient times and a number of landraces and traditional varieties grown earlier have been replaced by modern high yielding varieties. Walter Lawrence, the British Land Settlement Commissioner in his book "The Valley of Kashmir" have recorded a number of rice varieties and found 53 different varieties cultivated at a single place. Considerably high genetic erosion especially during second half of last century has resulted in loss of this variability to a great extent (Najeeb *et al.* 2014). Still one can see some variability in paddy fields in few remote high altitude areas of Kashmir. However, existing genetic diversity is seriously endangered. It has been reported that majority of the rice landraces in Jammu and Kashmir and adjoining Himalayan states of India have reached on the verge of extinction and may disappear from farmers field in next 5 or 10 years (Rana *et al.* 2009). Some of the important local land races of Kashmir valley documented by Sultan and Rao (2013) are Ambir Khan, Jamna Siri, Mush Kandi, Shahie, Aziz Beoul, Kamad, Mushuq Budij, Sater, Baber, Kamal Dar, Niver, Shalle Zag, Bal Kaun, Kathwur, Nune Beoul, Shuner, Barkat, Kawa Kuder, Prenie Babe, Siga, Begum, Khar Koot, Qadir Beig, Tcheri Bara, Bote Baber, Khet Gud, Qamroz, Tilla Zag, Brez, Kiri Rusi, Rahim Bara, Wat Zag, Cirka, Khuch, Ranji, Wuzul Kred, Drangi Bara, Lar Beoul, Rehman Bhati, Yemberzal, Geaw Zeer, Majeth, Resham, Zaged, Gulzag, Mirzag, Shalle Keau, Zagir, Jala Kred, Mehvan, Safed Brez, Zagi Tal.

Landraces and traditional varieties of rice have been utilized by inhabitants in Kashmir since hundreds of years and therefore hold a special position

in the cultural landscape heritage of the region. Unfortunately for many reasons, the genetic diversity of rice has considerably decreased in Kashmir in the last five or six decades. These varieties had their peculiar features and were preserved and cultivated by farmers throughout generations till recent past where they have been largely replaced by new varieties. The land races belonging to particular characteristic feature are presented in Table 1.

Table 1: Characteristic features of rice landraces

Characteristic	Land races
Aromatic	Aziz Beoul, Baber, Lar Beoul, Mush Kandi, Mushuq Budij, Qadir Beigh, Safed Brez, Shahie
Bold seeded	Aziz Beoul, Barkat, Bote Baber, Kamad, Kathwur, Khuch, Lar Beoul, Rehman Bhati, Shahie, Tilla Zag
Early maturing	Baber, Brez, Majeth, Niver, Qadir Beigh
Good swelling ability	Baber, Barkat, Kathwur
High yielding	Baber, Bal Kaun, Begum, Kathwur, Mehvan, Nune Beoul, Yemberzal
Non-sticky	Baber
Sticky	Kamad, Nune Beoul
Sweet and nourishing	Baber, Gul Zag, Niver

Sultan and Subba Rao, 2013

Regarding the maximum number of grains per panicle, most important are Baber, Kathwur, Mehvan, Nune Beoul. Threshing of these landraces according to farmers was generally difficult, more cumbersome in red rice cultivars (Najeeb *et al.* 2014). The cultivation of majority of these landraces which were particularly adapted to local environments and requirements has now been abandoned. However, few landraces for example, Mushq Budji, Kamad and some Zag varieties due to their unique characteristics and special use are still popular and cultivated at small scale especially in mid and high altitude areas of Kashmir (Sultan and Rao, 2013). These landraces are still maintained for social, ecological and economic values. Red rices, viz., Niver and Zag cultivars were often cultivated in high altitude areas as these varieties were hardier than white rices and withstood the chill of cold weather and were more tolerant to cold water from mountains entering first into the fields (Khan, 2016; Shikari *et al.* 2008). Besides, spiky glumes of red rices gave some protection to the crop against some wild beasts prevalent in these areas.

Aromatic local land races and their revival

More than 100 landraces have been documented from Kashmir valley, however, majority of them stand replaced from farmer's field by the high yielding varieties, and have been confined to some specific pockets of the valley (Najeeb *et al.* 2014; Sultan and Rao, 2013, Rouf *et al.* 2009). The preference for high yielding varieties has led to genetic erosion and loss of these valuable landraces which once were cultivated for several traits like taste, aroma, other unique quality features and medicinal use. The reasons attributed to loss of heritage rice's of Kashmir include their low yield potential and susceptibility to biotic and abiotic stresses particularly to paddy blast (Najeeb *et al.* 2010; Khan, 2016) besides introduction of HYV varieties by the R&D institutes and developmental departments concerned for the sector (Shaheen *et al.* 2016). A good number of landraces of rice are known from Kashmir mostly of *japonica* background and noted for their unique quality features which together impart desirable taste and texture to the cooked rice, besides, being early maturing and highly cold tolerant. These genotypes evolved under specific ecological niches are carrying combined adaptive traits for the temperate climatic conditions of Kashmir valley (Shikari *et al.* 2008). Inspite of the introduction of many high-yielding modern rice varieties, some landraces are still popular in the farmers' fields in isolated pockets due to their unique qualities as niche crops. It will be pertinent to mention here the names of *Mushkbudji*, *Kamad* and some red rices (Shaheen *et al.* 2016).

The realization of importance of genetic variability in rice improvement and awareness of consequences of genetic erosion has lead to increased initiatives at the state level for conservation of rice germplasm. In the valley, rice is grown under plain basins (1500-1650 m amsl) and higher belts extending from 1650-2400 m amsl. These ecologies have different varietal requirements. In lower belts *indica* rices are predominantly grown. China 1039, China 1007, K-39, *Jhelum* and Shalimar Rice-1 are commonly grown varieties in this region. In higher belts varietal group

is still more restricted and limited to the cultivation of K-332, Kohsar, and a few local landraces. The intermediate zone ranging between 1900 to 2000 m amsl (ecotone) is the niche belt of very important local biodiversity of rice (Najeeb *et al.* 2014; Shikari *et al.* 2013 & 2008).

Mushk Budji, one of the important and valued local land races is short bold aromatic rice grown in higher reaches of Kashmir valley. The cooked rice is unique and possesses harmonious blend of taste, aroma and rich organoleptic properties (Shikari *et al.* 2013). *Mushk budji* and *Kamad* revival programme was undertaken in 2007 by Mountain Research Centre for Field Crops, Khudwani of SKUAST-Kashmir with the objective to conserve local biodiversity through utilization for socio-economic development of rice growers which proved to be a huge success. Due to susceptibility of *Mushk Budji* to blast which results in frequent crop failures, a well researched program was undertaken to incorporate blast resistance genes viz Pi54, Pi1 and Pita into the genetic background of *Mushk Budji* (Shikari, 2013). Efforts by the scientists of SKUAST-K during last several years have led to control of blast for these aromatic land races to a large extent.

Economics of Paddy farming in Kashmir

In order to have a comparative picture of the economics of various paddy varieties, four common and widely adapted commercial varieties, viz., Jhelum, SR-1, China 1007 and China 1039 were enumerated for costs and returns besides three aromatic local land races (Mushk Budji, Kamad and Zug) of Kashmir. The costs for these varieties were calculated at three levels as followed in the Cost of Cultivation Scheme by Commission for Agriculture Costs and Prices (CACP) for formulating Support Price Policy in India. The varieties were found to vary in productivity levels with SR-1 giving higher yields (7 t/ha) out of the present varietal lots cultivated by farmers followed by Jhelum (6 t/ha) as depicted in Table 2. The aromatic local land races, which are site specific, were found to yield relatively low, particularly the Red Rice (Zug) with a meagre amount of 2.5 tonnes per hectare. The fodder yield was almost proportional to the grain yield across the varieties (Table 2).

The aromatic local land races yielding lesser than the main varieties such as Jhelum and SR-1 were found to make higher revenues due to relatively higher prices for the grain/rice. The farmers were getting about ₹ 40 per kg and ₹ 34 per kg grain for *Mushk Budji* and *Kamad* varieties, respectively as compared to Rs 16 per kg realised on non-aromatic varieties. The Red Rice (Zug) being scarcely grown was found to fetch ₹ 65/kg of grain on an average and milled and cleaned rice of same variety was not even available at ₹ 150 a kilogram during the survey. The value of by-product constituted from 7 per cent to 32 per cent of the total crop value per unit of land across the varieties. The value share of by-product (paddy fodder) was minimal in Red Rice and aromatic land races and maximum in Jhelum and SR-1 due to more biomass yield in latter varieties and on other hand higher market values of grains in case of aromatic varieties. The by-product as paddy grass fodder is dumped as winter fodder and fed to livestock besides its use in apple packaging in poplar wooden boxes as cushioning material and other utilities. The maximum return was found for *Kamad* and *Mushkbudji* varieties followed by Red Rice. Though *Kamad* fetches at lower price than *Mushkbudji* but due to proportionally higher yield than latter, it marginally overtakes the returns on per hectare basis (Table 2).

The costs were estimated at three levels (Cost A, B and C) for better discussion and comparison in subsequent stage with other states. Cost A is the all actual expenses in cash and kind incurred in production by owner farmer including imputed value of family labour. Most of the researchers other than from economics background do take only the operational expenses into account while calculating the economic viability of a crop enterprise without any due regard to fixed cost components and managerial costs. Here, the second level of cost (Cost B) includes interest on value of owned capital assets, rental value of land and depreciation on farm capital assets which includes farm machinery, implements and tools, farm buildings etc which gets added to Cost A. Cost C is the Cost B plus 10% of the Cost B as managerial services provided by a farmer. The costs worked out at three levels were more or less same across the first four varieties (Table 2), however, it is at upper side for *Mushkbudji* and *Kamad* because of the fact that relatively more labour is involved in cultural operations as well as on account of plant

Table 2: Economics of paddy crop cultivation of some common and important varieties in Kashmir valley (₹/ha)

Particulars	Varieties						
	Jhelum	**SR-1**	**China 1007**	**China 1039**	**Mushkbudji**	**Kamad**	**Red Rice**
Grain Yield (t/ha)	6	7	5.5	5.3	4.8	5.6	2.5
Fodder Yield (bundles)	910	980	857	849	845	880	325
Value of Main & by-product (₹/ha)	141500	152600	131000	126875	234250	234400	176580
Cost of cultivation (₹/ha)							
Cost A	95583	96870	94785	91765	103873	103508	75477
Cost B	118720	120007	117922	114902	127010	126645	98614
Cost C	130592	132007	129714	126392	139711	139309	108475
Net Returns (₹/ha)							
Over Cost A	45917	55730	36215	35110	130377	130892	101103
Over Cost B	22780	32593	13078	11973	107240	107755	77966
Over Cost C	10908	20593	1286	483	94539	95091	68105

protection measures due to its susceptibility to blast which shoots up the cost of cultivation. The Cost A varies from ₹ 75,477 for Red Rice upto ₹ 1,03,873 for *Mushkbudji*. The fixed cost components makes up almost ₹ 23,000 per hectare on an average among which rental value of land constitutes major share of cost structure. The Cost C at thirds level is 10% of Cost B added as management charge performed by the farmer.

Net returns over Cost A, B and C was worked separately at every level to examine the viability of crop after considering cost components at each stage. The maximum net returns over Cost A were on *Kamad* (₹ 1,30,892) and *Mushkbudji* (₹ 1,30,377) followed by Red Rice (₹ 1,01,103) and were recorded low in China-1039 (₹ 35,110). Similar trend was observed when net returns were compared across the varieties over Cost B and Cost C. Labour formed the major share (60%) of Cost A which includes both hired as well as family labour. On an average, 143 mandays were required for cultivating one hectare of paddy crop and was found relatively more for aromatic land races of *Mushkbudji* and *Kamad* and less for Red Rice due to low input use and biomass production for the latter.

A lot of scope exists for curtailing the costs on part of labour if mechanization can be introduced in paddy cultivation as evident from the neighbouring state of Punjab, where the mechanized paddy cultivation cost is significantly lesser than non-mechanized paddy farming (CACP Kharif Crop Report, 2016-17). The scarcity of labour in agriculture can be addressed by emphasizing farm mechanization which will reduce the cost of production and also increase income of the farmers. In view of high cost of farm machinery, a feasible way to promote farm mechanization is promotion of ''Custom Hiring Model" as being implemented in some states like Karnataka, and practiced by private service providers in Punjab and Haryana.

The idea of farm mechanization in paddy crop cultivation in Kashmir landscape seems vague because of terraced fields apart from marginal land holdings of individual farmers but cannot be thought-off if machines can be owned and operated on custom hiring basis as service provider companies which will reduce the costs substantially on part of soaring labour wages. Furthermore, labour wages are going to increase further in future because of the growing demand from other sectors. In this direction, Agricultural Engineering Department of SKUAST-Kashmir needs to devise new machines and/ or modify already existing farm machinery for various cultural operations to local conditions.

Comparing the economics of paddy crop cultivation with the major rice producing states of India, the SR-1 variety is at par with the Punjab (Table 3). When returns are considered over Cost C3/Cost C, Kerala is the second state followed by Punjab where net returns are better compared to states like Maharashtra, Oddisa, Uttarakhand and West Bengal as it arrives at negative returns to farmers.

Table 3: Economics of paddy crop cultivation for major Indian states (Rs/ha) (2014-15)

Items	Kerala	M.P.	Maharashtra	Odisha	Punjab	Tamil Nadu	U.P.	Uttarakhand	West Bengal
Cost of Cultivation (In ₹/Hectare)									
A1	42200	17277	30825	20502	25782	42470	21002	22778	28731
A2	42205	17277	30825	20653	31948	43027	21206	25638	29167
B1	42473	18941	34104	22468	28595	47095	24192	23952	30158
B2	59196	30641	43285	32592	59588	57861	35337	33350	42379
C1	44682	24766	43442	33538	33750	55225	32423	34833	43761
C2	61404	36466	52623	43662	64743	65991	43568	44231	55983
C3	67545	40113	57885	48028	71218	72590	47925	48654	61581
Value of main & by-product	83621	46801	55073	40288	91790	78442	50576	41564	48898
Returns over Costs ₹/Hectare)									
A2	41416	29524	24249	19635	59842	35415	29370	15926	19731
B2	24425	16160	11788	7696	32203	20581	15239	8214	6519
C2	22217	10335	2451	-3374	27047	12451	7008	-2668	-7085
C3	16076	6688	-2812	-7740	20573	5852	2651	-7091	-12683

Source: www.indiastat.com

The productivity of crop and factor costs plays an important role in determining the crop economics across the states. The labour forms the major cost component and the wage rates vary across the regions and states. Despite Punjab state having Cost C3 at higher side than other states, the net returns are maximum which may be mainly attributed to relatively better yields and price support and procurement policy besides effective mechanization.

Breaking tenant-landlord relationship

The profitability of paddy crop cultivation from the tenant's perspective was estimated in order to through light on the breaking relationship of landlord-tenant in crop enterprise. The costs and returns were estimated for the major crop variety Jhelum with 60 quintals of yield per hectare. The tenant gets 50% share of main and by-product which amounts to ₹ 70,750 for one hectare of paddy crop land cultivated. On the other hand, tenant incurs ₹ 95,583 as costs which includes seeds, fertilizers, manures, plant protection, bullock labour, tractor machinery and the labour – both hired as well as the imputed value of his own family labour employed on farm. Most of the tenants are in this business only because of their own resources in terms of bullocks, manures, seeds and particularly the family labour which get employed throughout the season and remain engaged. The tenant farmer makes negative returns of ₹ 24,800 if imputed value of family labour is also included into cost estimates. In other words, tenant gets ₹ 18, 067 as returns for employing 143 mandays of family labour over a period of 6-7 months on one hectare of paddy crop land. So the wages earned per manday by tenant family is to the tune of ₹ 126 (Table 4). It is a matter of grave concern for everyone to ponder that what makes a tenant farmer to cultivate leased in land on sharing basis or in other words why a tenant farmer should do paddy cultivation on leased in land when it earns very marginal wages to his family labour?

Table 4: Economics of paddy cultivation by tenant farmer in Kashmir valley (₹/ha)

Particulars	Variety (Jhelum)
Grain Yield (t/ha)	6
Fodder Yield (bundles)	910
Value of Main & by-product (₹/ha)	141500
Cost incurred by tenant (₹/ha)	95583
Tenant's share (50% of main & by-product) in ₹	70750
Family Labour (mandays/ha)	143
Tenants return over cost with imputed family labour value included (₹)	-24833

Tenants return without imputing value of family labour/ Returns to Family Labour (₹)	18067
Wages earned per manday by tenant family (₹)	126

Bridging the demand-supply gap

Sustainability of paddy cultivation in Kashmir is important as rice is the main staple food in the region with an average consumption of 270 grams per day per person. The rice production in Kashmir valley does not meet the local demand and is augmented by imports from outside state.

In order to sustain the viability of paddy framing and to compete with the imported rice, more emphasis needs to be given on better seeds through seed replacement; resource use efficiency for optimizing yields and reducing costs; bridging the yield gap through scientific and extension interventions (Table 5).

Table 5: Yield gap of some important rice varieties in Kashmir

Variety	Potential Yield (t/ha)	FLD Yield (t/ha)	Farmer's Yield (t/ha)
For Plain Areas			
Jhelum	5 - 6	6.5	5.0
Shalimar (SR-1)	6 - 7	7	6.2
SR-2	6.5 - 7.5	7.5	6.5
SR-3	6 - 6.5	6.75	5.5
China 1007	4.5 – 5.5	—	5.0
K 39	4.5 - 5	—	4.5
For High Altitude Areas			
K 332	3.5 - 4	4.0	3.75
Kohsar	4 – 4.5	4.25	4.0

Source: Rice Research Station, SKUAST-K, Khudwani.

SKUAST-Kashmir has already taken initiative for breeding of rice varieties suitable to local conditions with better yields and has released some promising varieties like Shalimar Rice-1 (SR-1), SR-2, SR-3, SR-4 and SR-5. These varieties are giving good yields on experimental stations. Shalimar Rice-1 released in 2002 has been widely adapted by farmers, particularly in South Kashmir. The study conducted by Wani *et al.* 2013 on the impact of SR-1 adopted by farmers have realised net returns 200-400 per cent higher to that of non-adopters. Furthermore, the economic surplus model (ESM) revealed that R&D investment has resulted into higher returns of 4.69 on each rupee invested. However, due to taste and other issues it could not sustain on the rice landscapes of Kashmir valley despite having better yields. So, the R&D efforts for the technological interventions should not be confined only to the breeding programs but also in disease control, mechanization and post harvest management which may bring higher dividends on the investment.

For a better extension services delivery and to disseminate latest technologies among farmers in the state, Frontline Demonstrations (FLDs) are being funded since 1998 in the valley. The impact of extension services delivery on technology adoption by farmers revealed the existence of technological gap in the application of inputs at both adopter and non-adopter farms. Besides inappropriate seed rates, both adopter and non-adopter farms had given under-dozes of N and P, and over-doses of K, causing a yield gap of about 25 per cent in adopter farms and 45 per cent on non-adopter farms which clearly shows that rice production can be augmented further by bridging the technological gaps (Wani *et al.* 2013).

Sustaining paddy cultivation under water scarce conditions

The autumn of 2017 was drought season coupled with lowest snowfall record from last 50 years which resulted the acute water scarcity in the Kashmir valley. The gravity of problem was so compounded that in the beginning of Spring 2018, the State Irrigation Department came up with advisory for the paddy growers to not go for rice seed sowing in the Kharif season of 2018 as the water levels in rivers and streams which used to be brimming and roaring, are at the lowest ebb. The paddy being as a water guzzler crop has to sustain with changing climatic conditions.

Land productivity, i.e. production per unit of area, reflects only one dimension and ignores natural resource like water, which is becoming scarce with every passing day. Punjab has the highest rice productivity (4 t/ha), followed by Haryana (3.2 t/ha) and Andhra Pradesh (3 t/ha). The per hectare water use by irrigation in these states is 161.78 lakh

litre in Punjab followed by Tamil Nadu (137.50 lakh litre) and Uttar Pradesh (102.00 lakh litre). As against these states, per hectare water use by irrigation in Assam, West Bengal and Bihar is 50 lakh litre, 59.86 lakh litre and 66 lakh litre, respectively (CACP Kharif Crop, 2016-17). If water consumption is measured in terms of per kilogram of rice, West Bengal becomes the most efficient state which consumes 2169 litre to produce one kg of rice, followed by Assam (2432 litre) and Karnataka (2635 litre). The water use is high in Punjab (4118 litre), Tamil Nadu (4557 litre) and Uttar Pradesh (4384 litre). It shows that the most efficient state in terms of land productivity is not necessarily the most efficient if irrigation water is factored into. This is because of high rainfall in the eastern region. The country's farm sector alone accounts for 83 percent of total water use. It is, therefore, imperative to augment the water productivity.

Table 7: Water footprints of paddy crop across states (cubic metre/tonne)

States	Green	Blue	Grey	G+B
Punjab	1020	1007	200	2028
H.P	1662	515	243	2177
J&K	1088	781	222	1869
Harayana	1216	1241	199	2458
Tamil Nadu	823	1027	220	1850
Kerala	1908	416	214	2324
Karnataka	1536	747	235	2283
A. P	1462	608	213	2069
W.B	1399	131	216	1529
Bihar	1460	435	222	1895
U.P	1414	649	211	2063
Assam	1402	15	210	1417
All India	1394	452	224	1846

Source: Water Footprint Network.

Water Footprint Network classifies water usage into three types: green (rain water); blue (surface and groundwater); and grey (amount of water required to carry off pollutants). A large total water footprint was calculated (Table 7) for wheat (1087 $Gm^3\ yr^{-1}$), rice (992 $Gm^3\ yr^{-1}$) and maize (770 $Gm^3\ yr^{-1}$). Wheat and rice have the largest blue water footprints, together accounting for 45% of the global blue water footprint. At country level, the total water footprint was largest for India (1047 $Gm^3\ yr^{-1}$), China (967 $Gm^3\ yr^{-1}$) and the USA (826 $Gm^3\ yr^{-1}$). A relatively large total blue water footprint as a result of crop production is observed in the Indus river basin (117 $Gm^3\ yr^{-1}$) and the Ganges river basin (108 $Gm^3\ yr^{-1}$) (Mekonnen & Hoekstra, 2011).

These two basins together account for 25% of the blue water footprint related to global crop production (Mekonnen and Hoekstra, 2011). The state of Jammu and Kashmir is an upper riparian for western rivers of Indus basin which have been allocated to Pakistan with minimal use for irrigation and hydropower generation under Indus Water Treaty 1960s (World Bank, 1960). So under the permissible irrigation limits, it needs to use its water resource efficiently, more particularly in case of agriculture sector which is consumptive for water use. Rice being as a water guzzler crop with high water foot prints needs to be managed efficiently with respect to water use. Due to climate change and dwindling water resources, paddy crop has to brace the future water shortages and efforts are needed right from breeding program for water resilient or less water consuming rice varieties upto on-farm efficient water technologies for crop production besides minimization of losses in delivery mechanism through proper management of canals and field channels.

CONCLUSION

Rice will remain an important and staple food for the people of Jammu & Kashmir. However, there has been considerable decrease in area under paddy cultivation in Kashmir valley due to switch over to horticulture crops particularly apple orchards besides housing and developmental projects. Though, the productivity levels got improved over time, still the gap of self sufficiency is widening which is evident from the growing import and off-take of rice stocks and burgeoning rationed population under PDS system of the state. As land has pressure from other sectors and within agriculture sector, paddy crop faces tough competition from other crops, particularly horticulture sector, in terms of economic viability. There have been certain attempts in formulation of improved rice technology through release of new varieties and revival of some aromatic land races with commercial value in order to increase the profitability of crop, but rigorous efforts are needed to sustain the rice landscape of Kashmir

valley on long term basis. The rice cultivation faces challenges from shrinking area due to competition from other sectors and crops, growing urbanization and demand for development projects, climate change and dwindling water resources, besides market factors. Due to climate change and dwindling water resources, paddy crop has to withstand and efforts are needed right from breeding program for water resilient rice varieties onto on-farm efficient water technologies for crop production besides minimization of losses in delivery mechanism through proper management of canals and field channels.

REFERENCES

Commission for Agriculture Costs and Prices (CACP). 2016. Price Policy for *kharif* crops, Marketing Season 2016-17, New Delhi, accessed at http:// cacp. Dacnet .nic. in/View Questionare.aspx ?Input=2& DocId= 1& PageId=39&KeyId=574.

Comprehensive State Agricultural Plan (Jammu & Kashmir). 2015. Directorate of Research, Sher-e-Kashmir University of Agricultural Sciences & technology of Kashmir, Shalimar, Srinagar, J&K, India.

Directorate of Economics and Statistics (DES). 2016. Statistical Digest 2015-16, Directorate of Economics and Statistics, Planning and Development Department, Jammu and Kashmir, accessed at http://ecostatjk.nic.in/ publications /publications.htm.

Economic Survey. 2016. Directorate of Economics and Statistics, Planning and Development Department, Jammu and Kashmir, accessed at http://ecostatjk.nic. in/ publications /publications.htm.

Kaloo, M.J. and Choure, T. 2015. Status of rice production in J&K: an economic analysis, *International Journal of Applied Research*, **1**(9): 359-363.

Kaloo, M.J., Patidar, R. and Choure, T. 2014. Production and productivity of rice in J&K: an economic analysis, *International Journal of Research*, **1**(4): 464-473.

Khan, G.H., Shikari, A.B., Shabir, H.W., Sofi, N. and Parray, G.A. 2016. *Mushk Budji*-aromatic land race of Kashmir, *Journal of Rice Research*, **4**: 1.

Khan, G.H., Shikari, A.B., Vaishnavi, R., Sofi, N., Padder, B.A., Bhat, Z.A., Parray, G.A., Bhat, M.A., Kumar, R. and Singh, N.K. 2018. Marker assisted introgression of three dominant blast resistant genes into an aromatic rice cultivar *Mushk Budji*, Scientific Reports, Article No. 4091 (2018) accessed at http://www.nature.com/ aricles/s41598-018-22246-4.

Lawrence, W.R. 1895. The Valley of Kashmir, *London H. Frowde Publishers*, 1895.

Mekonnen, M.M. and Hoekstra, A.Y. 2011. National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No.50, UNESCO-IHE, Delft, the Netherlands, accessed at http:// waterfootprint.org/media/downloads/Report50-NationalWaterFootprints-Vol1.pdf.

Mekonnen, M.M. and Hoekstra, A.Y. 2011. The green, blue and grey water footprint of crops and derived crop products, *Hydrology and Earth System Sciences,* **15:** 1577–1600.

Akmali, M. 2017. In a decade ten thousand hectares agriculture land converted in *J&K, Daily Greater Kashmir*, February 10, 2017.

Najeeb, S., Shikari, A.B. and Parray, G.A. 2014. Status paper on rice in J&K, accessed at www.rkmp.co.in.

Mir, R., Shikari, A.B., Singh, S.G. and Parray, G.A. 2009. Genetic divergence studies in high altitude temperate rice (*Oryza sativa* L.), *Asian Journal of Experimental Sciences*, **23**(3): 487-490.

Shaheen, F.A., Wani, S.A., Parray, G.A., Sofi, N. and Bhat, M.A. 2016. Growing distress in rice economy of Kashmir valley, Policy Paper No. 07, Directorate of Research, SKUAST-K, Shalimar, Srinagar, J&K.

Shikari, A.B., Khanna, A., Krishnan, G.S., Singh, U.D., Rathour, R., Tonapi, V., Sharma, T.R., Nagarajan, M., Prabhu, K.V and Singh, A.K. 2013. Molecular analysis and phenotypic validation of blast resistance genes Pita and Pita2 in landraces of rice (*Oryza sativa* L.), *Indian Journal of Genetics & Plant Breeding*, **73**(2), 131-141.

Shikari, A.B., Hussain, S.Z., Parray, G.A., Rather, A.G. and Wani, S.A. 2008. Physico-chemical and Cooking Properties of Non/basmati Temperate Rice (*Oryza sativa* L.), *Crop Improvement*, **35**(2): 109.

Sultan, S.M. and Rao, S. 2013. Germplasm collection from last remnants of rice land race genetic diversity in high altitude areas of Kashmir Himalayas, *International Journal of Conservation Science*, **4**(4): 467-476.

Wani, M.H., Baba, S.H., Sundaram, P.R., Yousuf, S. and Yousuf, S. 2013. Has adoption of improved rice technology enhanced economic and livelihood security in Kashmir Valley, *Agricultural Economics Research Review*, **26**(Conference Number) 2013: 165-171.

World Bank. 1960. Indus Water Treaty 1960, accessed at https://siteresources. worldbank.org/ INTSOUTHASIA/Resources/223497-1105737253588/ IndusWatersTreaty1960.pdf.