Review of research and development interventions in up land rice and assessments of its Impacts : Cases from the Eastern Bhutan

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Abstract

Research initiatives of RNR RDC Wengkhar in upland rice between 2004 and till date are revisited and impacts studied in 2011-12. Upland rice cultivation which declined over the years have seen its revival with efforts of research, extension and farmers through the research outreach programs. A combination of research and technology promotion in farmers field resulted in up scaling upland rice varieties namely Khangma Map from the research station to villages surrounding the research stations and further into to remote and far flung areas where some differences have been made. More than 700 farming households in some 13 sites across six Dzongkhags today cultivate Khangma Map covering more than 250 acres and harvest an average yield of 0.7 t/acre to 1.3 t/acre. The cultivation of Khangma Map has enabled farmers to reduce their rice purchase by 30-40 % there by making a small contribution towards household food security.

Key Words: *Upland rice, research outreach, household food security, impacts*

1. Introduction

Upland Paddy Cultivation was an ancestral practice in eastern Bhutan in the lower and mid altitude regions, locally referred as *Pangbara* in the east and *Kambja* in the western part of Bhutan. With farming systems in the past dominated by shifting cultivation, it suited *Pangbara* cultivation. However, upland rice cultivation declined over the years mainly due to shifting farming systems to permanent based dry land and wetland farming system, availability of technological options of suitable crops with better yield and crop performance; declining yield and seed quality over the years and availability of cheaper rice through fair shops and markets.

But in recent years upland rice cultivation has caught the interest of some farmers residing above 1500 masl in the eastern Dzongkhags. This began mostly with a farmer led trial of using a new rice variety *Chumroo* or *Khangma Map* in Khangma, Trashigang sometime in 2004. This variety released for wetland system in 1999 was found to be equally good under dry land conditions. Accordingly, RNR RDC Wengkhar field crops began working on firstly starting wider testing of *Chumroo* under dry land conditions with farmers followed up by evaluating new varieties suitable for upland conditions and traditional variety screening as there was already existing traditional line which farmers may prefer.

Upland rice once again began to establish in the areas with elevation ranging from 1500 – 2300 masl with interventions of both research and extension following a concept of research outreach. The works of the RNR RDC Wengkhar in reviving *Pangbara* or *Kambja* between 2004 to 2010 are reviewed and its impacts assessed in this paper.

2. Methodology

A total of twelve different varieties of rice were evaluated on station mostly in Khangma Research Centre for upland conditions and promising ones from the trials were taken to farmers field through production trials, demonstration, field days and Participatory

Variety Selection (PVS) following the concepts of research outreach mainly to diversify the maize based cropping system between 2004 and 2011.

In doing so, the research centre first multiplied good quality basic seeds, identified interested farmers and sites and began promotion alongside on station research in evaluating variety selections and screening of existing traditional lines. In larger scales, development projects securing adequate funds to provide a complete package of cultivation practices and inputs were developed and implemented.

Subsequent to the research and promotion of suitable varieties under dry land conditions in the last six years, the interventions of the research centre both in research and promotion of the crop in outreach sites are revisited following semi structured interviews with growers and conducting focused group discussions. The sites were visited and field situations assessed through field days Participatory Variety Selection (PVS) carried out involving research, extension, cultivators and potential cultivators and conducted different case studies to assess the impacts.

With low seed availability for cultivation, basic seed production were increased alongside farmers exchange or sale of seeds facilitated. The Dzongkhag and geog extension programs were developed and implemented with the extension.

3. Findings

Research and technology promotion approaches and processes

Research intervention in sites where traditionally upland rice was cultivated and those which seem to have potentials based on the agro ecological suitability were identified as outreach sites in which researchers, extension and farmers were brought together working on the cultivation of the crop in a following a focused outreach approach unlike the conventional on farm research carried out in smaller scales (See Box 1. Concepts of Research Outreach).

The use of these technology promotion approaches best suited adaptive and basic research and effectively demonstrated its applications and fine tuning of the process. This success has led to its replication into other research programs such as the Community Based Seed Production Program in Maize, creation of outreach sites for fruits and vegetables promotion and up scaling the reach of research beyond the research centre.

Box 1. Concepts of research outreach

- *Farmers, researchers and extension begin promotion of a variety with the recommended cultivation practices in one or two farmer's field.*
- *At various stages of the production, other farmers from nearby or likely potentials sites from other areas are called to observe the ongoing cultivation. This is organized usually in field days and training programs. Farmer to farmer extension is facilitated so that the growers interact with others to encourage them take up the cultivation of the variety*
- *At the time of harvest or prior to harvest, another field day is organized where identified growers for the following year or any others interested are called in. A participatory assessment of the crop is carried out.*
- *Depending on the interest and willingness of the farmers participating in the field days and assessment, growers for the following year is identified and accordingly, seeds from the research centre is arranged or from the grower in the particular year encouraging farmer to farmer seed sharing.*

Source: Adapted from Dorji et.al., (2009)

Research on upland rice

Research works carried out to support the revival of the upland rice is elaborated in detail in Katwal, *et.al.,* (2008). A summary of the research outputs from this publication is shown below:

- About ten varieties composed of both improved and traditional lines were evaluated of which four varieties i.e. Chandanath 1 and *Machapucharey* were introduced from Nepal and Zangthi 1 and Zangthi 2 local lines from Zangthi geog under Samdrupjongkhar were found to have potentials as upland cultivars yielding average production of 1.00 – 2.11 t/ha.
- Agronomic characteristics of these varieties were also studied based on which some of these varieties such as Chandhannath 1 despite higher yield had lower preferences due to difficulty in threshing while varities such as local *Sambara, China 7 and Zangthi-3*

were found to be prone to severe leaf and neck blast and *Yusirey Kap* gave sterile grains.

- Since upland rice is rain fed, its planting time has to fit with the onset of rainy season. Ideal sowing time has been identified by studying both rainfall patterns and production trials. The most appropriate sowing time for upland rice has been identified the last week of March to the last week of April. However, this is more of a generalized recommendation and caution has to be takes since large variation in micro climate exists requiring location specific recommendations.
- Appropriate seed rate for which can be economical for farmers have been recommended through field research. The seed rate of 30 to 60 Kg/ha (12 to 25 Kg/acre) which can give an average of yield ranging from nearly 1000 up to 1300 Kg/acre is recommended.

The research works and its findings have impacted on the ability of the research sectors to move into technology promotion with confidence and effectiveness.

Impacts of Upland rice cultivation in the sites

One of the major impacts of the upland rice in the region can be understood from its expansion from research station to farmers field particularly to far flung areas. Rice varieties namely *Khangma Map* (released as *Chumroo*), *Machapucharey 2* (Introduced from Nepal) and *Zangthi 1* and *2* (local selections from Samdrupjongkhar) were taken to on farm research sites in Trashigang (Khaling, Kanglung, Bartsham), Mongar (Dremtse, Mongar Phosrong, Drepong, Kengkhar, Jurmey), Lhuntse (Jarey), Yangtse (Bumdelling), Samdrupjongkhar (Lauri and Serthig) and Pemagatsel (Zobel, Chimong).

An analysis of the trend in the uptake of cultivating rice under dry land – upland indicated successful revival of upland rice cultivation. What began on a small scale on farm trial in Kanglung, Trashigang in 2004 and Phosrong, Mongar in 2006 had spread to about 13 different sites across the six Dzongkhags by 2011.

Annually, about 400-500 kgs of seeds were supplied from RDC Wengkhar alone and about 700 households in 28 gewogs so far have taken up upland rice cultivation

successfully covering an estimated area of over 254 acres with seeds procured by Dzongkhags from NSC Paro. There has been increase in area of cultivation ranging less than a *langdo* (0.33 ac) per household to more than an acre now. There are even cases of government land being leased to grow upland rice as shown from Norbugang Gewog, under Pemagatshel Dzongkhag. Another significant impact is from the contribution of upland rice in reducing the purchase of rice from shops in the outreach sites. Rice purchase in outreach sites has gone down by 30 - 50 % as the upland rice substituted imported rice indicating the contribution of upland rice in household food security.

Some of the notable cases of the revival and its impacts at household levels are presented in the following sections:

Case 1. Upland rice in Kanglung, Trashigang 2004: The beginning of the revival

With most research works on upland rice carried out in Khangma Sub centre, Kanglung village happened to be the first where revival began. One farmer, Ap Naku aged 64 is a retired service personal living with his family of nine cultivated their two acres of dry land. Maize, Potato and some vegetables were the main crops. Maize was cultivated mainly for food while some parts of potato and vegetables were sold at the local market to buy rice and essentials.

He received about 500 grams of Khangma Map which by then was given for promotion into farmers field as upland variety. Using his traditional practices of seed broadcasting method, a small farmer trial began. After many years, he saw for the first time notable results. A single hill produced about 8-10 tillers with which a total of about 40 kg was harvested from his trial, which took him by surprise. His neighbors took some of the yield for seed and he then up scaled cultivation to about 0.66 acres in the following season (2005) giving him about 600 kg (about 1200 kg per acre). This yield was sufficient for him for the winter in which he did not have to buy any rice while he could also feed the straw to his cattle. By then, more farmers came to him looking for seeds. Some he directed them to the extension office and the research centre.

In 2005, he then renewed his seeds from the research centre and this time he took 5 kg and cultivated on the 0.66 acre rotating with maize and potato. By end of 2005 geog extension centre recorded a total of 60 households cultivating 12 acres of rice variety Khangma Map with an average yield of about 1000-1200 kg per acre. The red color of the grain, good taste and performance of the variety in dry land conditions led to the uptake and the only problem faced by the farmers were few incidences of white grub infestations but it was not severe to discourage them. Farmers of Kanglung still continue to cultivate the variety. Today, upland rice is cultivated in more than five geog covering an total area of about 45 acres in Trashigang.

Source: Wangdi, undated

Case 2. From Kanglung to Mongar and beyond, 2004 to 2010

With the shifting of the RNR Research Centre in the east from Khangma, Trashigang to Wengkhar, Mongar in 2004. The centres works in upland rice research out reach took a turn towards moving into areas beyond Khangma where there is potential for upland rice.

One of these seemingly potential site is Mongar and Depong geog under Mongar Dzongkhag. The centre using the outreach concepts of promoting crops through on farm research and demonstration began the continuation of upland rice promotion with a farmer Ap Sangay in Tasanglung (2050 m asl) under Mongar geog in 2004. By 2005, the upland variety Khangma Map spread to Laptsa village (> 1800 m asl) under Depong geog of Mongar Dzongkhag. By involving farmers of a potential areas in field days and demonstration activities conducted in partnership with the geog and Dzongkhag Agriculture extension, the field crops research sector managed to initiate a cumulative process of increasing more areas and farmers in the geog through which about 50 farming households in Laptsa village had put some 21 acres under Khangma Map cultivation by 2008 (see Figure 4). By 2009 more than 60 farmers have brought their 25 acres under cultivation.

Maintaining the process of involving potential growers of the following season in field days conducted at the previous year in collaboration with extension centers using farmer to farmer extension methodologies, Khangma Map spread beyond Depong geog by 2009 into areas such as Tsamang, Tsakaling, Kengkhar, Thangrong, Chaskhar, Jamcholing, Broksar, Dremtse all under Mongar Dzongkahg and then to Khaling under Trashigang. By then, Khangma Map was cultivated in more than 50 acres with average yields of 1-1.8 t/acre.

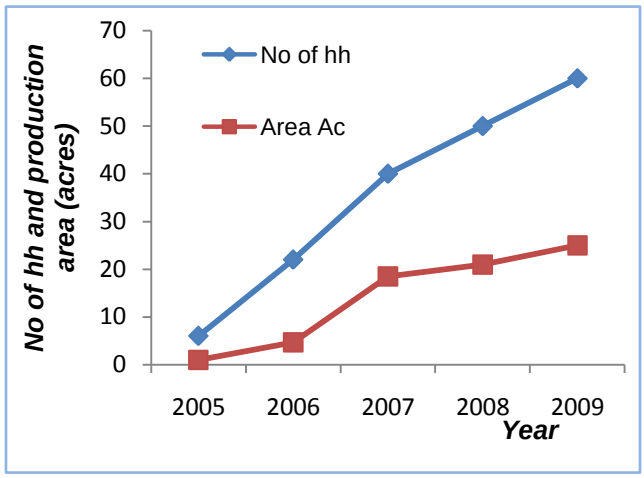

Figure 4. Trend in No. of hh and Production area for upland rice in Depong geog. Source: Wangchuk, *et.al*., (2011)

Khangma Map cultivation as upland rice, further moved into more areas where upland rice used to grow. In 2010 onwards, places such as Tshelinggor, Zobel , Chongshing geog and Chimong geog under Pemagatshel had also taken up the variety with more than 60 farming households harvesting average yield ranging from 0.7 to 1.3 tons per acre.

Source: Wangchuk et.al.2011; Dorji, L and Katwal, T.B., 2009 ; Choney, 2009.

Case 3: Supplementing household food at times of disaster with upland rice: The case of Tsanglung Mongar and Bumdelling, Trashiyangtse in 2006

In 2004, a flash flood in Bumdelling valley under Trashiyangtse damaged the wetlands therby reducing the rice cultivation. RNR RDC Wengkhar in 2005 demonstrated upland rice cultivation in small plots which gave good results following which in 2006 farmers began cultivating two varieties Khangma Map and Machapucharey 3 with average yield of 0.9 t per acre and 1.7 t per acre for Khangma Map and Machaphucharey 3 respectively . After this, Bumdelling geog had been able to cultivate the varieties covering 4-5 acres.

In 2006, maize in higher elevation above 1700 m als was severely affected by fungal diseases namely Turcicum Leaf Blight and Gray Leaf Spots. A farmer Ap Sangay who began experimenting in 2004 took another step in intercropping Khangma Map with Potato and maize crops. Since maize yields declined with disease infestations, his household grain requirements were supplemented with the upland rice thereby reducing his rice purchase by almost 50 %. Like him, others who took up upland rice were also able to reduce their purchase of rice from shops (see Figure 5).

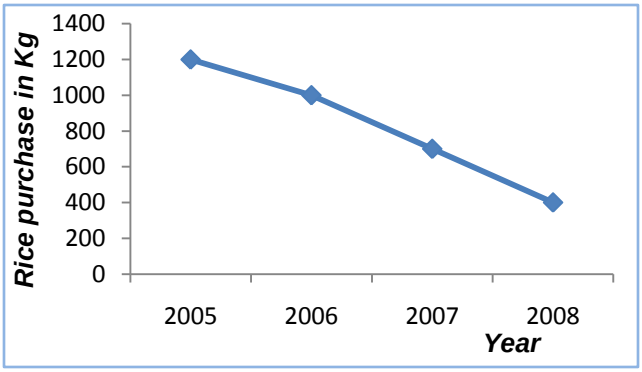

Figure 5. Trend in rice purchase in farmers adopting upland rice.
Source: Wangchuk, *et.al*., (2011)

Source: RNR RDC Wengkhar (2005) and Wangchuk et, al., 2010

Case 4: Reviving upland rice in Kheng (Mongar), Norbugang and Dechenling (Pemagatshel): A case of connecting poor farmers with Global Environmental Facility Grants

Poverty incidences and food shortages are generally more severe in remote geogs and therefore, RNR RDC Wengkhar having successfully worked on research and development in upland rice initiated a small Grants Program focusing on four furthest geogs in the region i.e. Silambi, Gongdue under Mongar Dzongkhag and Norbugang, Dechenling under Pemagatshel Dzongkhag.

The project titled "Promoting upland paddy and Vegetables: Ensuring food security through diversification of crops in dry lands of remote geogs of eastern Bhutan" implemented from June 2009 to June 2012 has been the major factor in spreading the upland rice varieties in these remote geogs.

Through this project interventions and Dzongkhags crop promotional programs under upland rice component; more than 100 farmers have revived the cultivation of upland rice adopting the new variety Khangma Map. By 2012, more than 80 acres are brought under cultivation with average production areas ranging from 0.33 acres to 1 acre harvesting average yields of 0.648 to 1.05 t/acre (See Table 4).

Table 4. Impacts of upland rice in four remote geogs of eastern Bhutan

Indicators	Mongar Dzongkhag		Pemagatshel Dzongkhag		
	Silambi Geog	**Gongdue Geog**	**Norbugang geog**	**Dechenling geog**	**Total**
No. of farmers	66	28	12	23	129
Production Area Acres	60	6	11	7	84
Average Crop yields t/acre	1.05	0.950	0.648	0.877	

Interventions in reviving upland rice in Silambi has impacted on the re cultivation of fallow lands which otherwise would have been kept without any production. These remote areas depend mostly on maize as a food crop and rice is mostly purchased from the shops situated 2-3 walking days away from their village. Rice in Silambi brought from Lingmethang (3 days walk) costs about Nu. 65 - 70 per kg is one of the most expensive commodities. The upland rice cultivation on average has reduced the rice purchase by 40 % enabling farmers to have good quality food grain supplement locally produced by themselves and upland rice has a good prospects in rural communities.

Farmers perception on upland paddy

Participatory Evaluation of the varieties encourages farmer to farmer extension of experiences, observations and over all assessments. The characteristics of *Khangma Map* or *Chumroo*; red colour, good taste and adaption in the sloppy dry land has encouraged farmers to grow the variety. In 2007, maize diseases (*Gray Leaf Spots and Turcicum Leaf Blight*) that caused considerable loss to the entire maize growing areas threatened to result into food shortages in affected households in eastern Bhutan during which upland rice came as indispensable in ensuring food security. Some of the farmers perception on the cultivation collected during field works are shown in Table 5.

Table 5. Advantages and disadvantages of upland paddy based on farmers perception

Advantages of upland Paddy	Disadvantages of upland Paddy
• A good option to produce rice for farmers who do not own wetlands • Contribute to enhance household food security and reduce purchase from shops • Paddy straw can be fed to cattles more palatable than maize stover • An alternative crop for maize when affected by disease • Crop guarding is easier than in Maize or other crops • Suitable for steep unused land and requires less water; completely rain fed • Cultivation is easier without having to transplant	• Intensive weeding which is done usually thorugh manual operations. Common weed species are *Agertatum conyzoides (rogphu-ngon*), *Galinsoga parviflora* (*Yurungpa*), *Fagopyrum dibotrys* (*themnang*) *Persicaria nepalensis* (*gangchimin*) and other grassy weeds. • Prone to damage by birds prior to harvest and white grubs at vegetative stage • Less yield and diverse use than Maize, a popular cereal in the region • Lack of quality seeds • Not suitable for small land holders unlike maize

Reasons for renewed interest on upland rice cultivation

The revival of the upland rice is found to be mainly due to the following reasons:

- A suitable variety *Khangma Maap* that has adapted well under upland ecosystem and can grow up to 2300 masl was available
- Land which was earlier sites for shifting cultivation later converted to dryland and owned by farmers was available
- It was an opportunity for farmers without wet land to cultivate rice
- Rice being a staple crop, its demand continue to increase
- Unlike wetland paddy, upland rice cultivation require less costs in inputs and irrigation as it was cultivated in dry lands with a fallow period retaining both soil fertility and soil moisture
- Upland rice technologies were successfully promoted through the research outreach program by different research centers.

- Vigorous promotion of the crop by the extension services through supply of free seed
- Fund for promotion of upland rice in remote areas through UNDP- Global Environmental Facility (GEF) were made available
- Upland rice has proved to be a suitable niche crop for maize based system especially in the wake of Gray Leaf Spot (GLS) and Turcicum Leaf Blight (TLB) diseases infections of maize in higher elevations above 1200 m as a result of continuous mono-cropping practices

Development of research Publications

The outreach programs on upland rice has impacted on developing suitable technical documents and extension materials providing sufficient information for reference and future research works. Some of these publications developed and disseminated are as follows:

- Upland Rice in Eastern Bhutan, Prospects and Perspective, RNR Research Centre Wengkhar Technical Document 38/FC/2008 RNR RC Wengkhar
- Revival of Upland Paddy (Kambja) cultivation: A case of diversifying maize based cropping system and enhancing household rice self sufficiency. Published in Sanam Drupdrey, March 2011. ICS, MOAF
- Upland Rice Technology helps farmers produce their most preferred staple food in eastern Bhutan: reviving Pangbara with research interventions. RNR RDC Wengkhar News and Views, Issue 18, Jan-March 2007
- Upland paddy cultivation, reintroducing the crop in farmers field. CoRRB News Letter, MoAF Vol VIII, March 2009
- Upland rice becoming popular in the east, an update. CoRRB News Letter, MoAF. Vol II, Issue 4 December, 2009
- Upland paddy cultivation practices. RNR Extension Material 2010. RNR RDC Wengkhar

4. Conclusions

The impacts of upland rice firstly demonstrated the benefits of channeling research and development interventions in a crop which is otherwise left aside with technical jargons

such as “minor cereal” and now reworded as “Other cereals”. *Pangbhara* is found to be instrumental in supplementing household food sufficiency on a smaller scale and remote areas where other opportunities are limited. Evidences from the cases in the outreach sites showed that a combination of traditional practices i.e. upland rice or *Pangbhara* with new and higher yielding varietal options or screening of existing traditional varieties and improvement in cultivation practices can lead to a larger impact and the technology promotion process replicable into other bigger and more viable technologies in agriculture development. The success of the works in upland rice as mentioned in the earlier sections is a clear demonstration of the concerted and focused efforts from major stakeholders i.e. research, extension and farmers.

With upland rice requiring less water (being rain fed), it has its potential in its way towards making a small contribution in ensuring rice sufficiency at the household levels in remote and far flung areas where farmers do not own wetlands or in situations of acute irrigation shortage or unreliable irrigation water in present scenarios of negative impacts of changing climate. The versality of the existing traditional cultivars and its easy adaptation to local conditions can also provide some options for climate change mitigation measures to ensure household food security.

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