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Technical Brief

Flood Adaptive Rice Cultivation Practice

Practical Action: Transforming lives, inspiring change

July, 2018

Introduction

Rice is the major food staple of Nepal and South Asia. It covers more than 50 per cent of total edible cereal production and about 20 per cent to the Agriculture Domestic Product (AGDP) in Nepal[1]. During 2015/2016, rice crop covered almost 1.3 million ha land in Nepal with the average productivity of 3.3 t/ha[2]. Compared to other rice producing countries, rice production in Nepal is quiet low as it suffers from different constraints of abiotic and biotic stresses, low or poor access to input, poor management, poor irrigation and lack of technical knowledge.

Photo 1 Swarna Sub-1 after flooding for 15 days *Photo Courtesy- RARST, NARC, Tarahara*

Extraordinary geography, poor institutional management capacity and recent trend of climate change have further exacerbated rice production challenges in Nepal. Almost 50 per cent of the area of rice cultivation in Nepal is rain fed, 30 per cent irrigated and 15 per cent is estimated to be affected by flash flood. The rain fed lowland that is prone to drought and seasonal flooding covers 104,720 ha of land[3]. Most climate projections for the region suggest that rainfall is likely to intensify and that extreme events like flood and drought will become even more frequent[4] . So, it is necessary to adopt rice production technology adaptive to submergence (flash flood), one of the major rice production constraints, predicted for the coming years.

1 ABPSD. 2014. Statistical information on Nepalese agriculture 2013/14. Agriculture Business Promotion and Statistics Division-MoADC, HMG/N, Singhdurbar, Kathmandu. 212p.

2 Ministry of Agricultural Development, Food and Agriculture organization and World Food Programme. 2015/2016. Crop Situation Update: A joint assessment of 2015/16 summer crops and outlook of 2016 winter crops (retrieved on 23/12/2016). http://reliefweb25736.rssing.com/browser.php?indx=43752042&item=101

3 Central Bureau of Statistics, Nepal: National Sample Census of Agriculture Nepal 2011/2012 (retrieved 11/7/2016). http://cbs.gov.np/image/data/Agriculture/National%20Level/NATIONAL%20REPORT%2020 11_12.pdf

4 US Environmental Protection Agency: Future of Climate Change (retrieved 11/7/2016). https://www.epa.gov/climate-change-science/future-climate-change

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Rice variety suitable for flood prone areas

In general, farmers adapt to different crop management strategies like adjusting planting time based on flood prediction and double transplanting to cope with flood disaster. However, such management strategies alone cannot fully address the adverse effect of flood as rice dies within 7 to 10 days upon complete submergence[5] . These losses affect rice farmers severely in rain fed and flood affected areas where alternative activities for livelihoods are limited. Nepal Agricultural Research Council (NARC) in collaboration with International Rice Research Institute (IRRI) developed three flood tolerant rice varieties for Nepal that can withstand flash flood up to 15 days (Table 1). These varieties have potential to regenerate even after 10 to 15 days of complete submergence (Photo 1). Besides tolerance to flood, these varieties are also reported to show some tolerance to different diseases in rice like rice blast and bacterial blight[6] upon activation of submergence gene.

Photo 2 Wet bed rice nursery established in pilot programme for Climate Resilient Agriculture (PPCR) by Practical Action Consulting (PAC)

Table 1 Recommended submergence tolerance varieties with their agronomic traits

Variety	Crop duration (days)	Plant height (cm)	Delay in harvesting when submerged	Yield (t/ha)
Swarna Sub1	150 - 155	85 - 95 cm	10 - 15 Days	Delay 4.5 - 5.0
Samba Masuli Sub1	45 - 150	190 - 100 cm	10 - 15 Days	Delay 4.0 - 4.5
Ciherang Sub1	125	105 cm	10 - 15 days	Delay 4.0 - 4.5

Cultivation methods and consideration

Though above varieties (Table 1) show maximum tolerance to flash flood and inundation, it is necessary to consider some technical aspects of modern rice cultivation practice; weather forecast and other production related information of the location should be taken into consideration. This information and consideration will help farmers to develop concrete rice production plan avoiding production constraints and enhancing rice yield.

1. Planting time

These varieties are usually planted as main season crops which is during June/July. Based on the climate forecast, transplanting time should be adjusted in such a way that seedlings will be at least 15 days old before flood appears. This will provide seedlings enough time to establish and build strength to withstand flood. Normally last week of May to the last week of June is considered best time for nursery establishment.

5 Xu, K.; Xu, X.; Fukao, T.; Canlas, P.; Maghirang-Rodriguez, R.; Heuer, S.; Ismail, A.M.; Bailey-Serres, J.; Ronald, P.C.; Mackill, D.J. Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice. Nature 2006, 442, 705–708.

6 Chaudhary, B. 2016. Resistance in Sub1 and non-Sub1 rice to blast, bacterial blight and sheath blight under different submergence periods; and influence of microbial seed treatment on leaf blast. PhD Dissertation. 102p

2. Nursery establishment and management

If we use transplanting method rather than direct seeding, it is necessary to prepare nursery bed. Healthy seedling leads to healthy production, so proper care should be taken while raising seedling in nursery bed.

A. Nursery type and size

Nursery type and size depends upon the soil type, climatic condition at the time of seeding and total area to be cultivated. Raised and dry bed will be suitable during monsoon or when there is intermittent rainfall (Photo 2). Sunken and wet bed will be more suitable during dry season/prior to monsoon. Similarly, size of nursery bed should be 1 m wide and up to 10 m long; nursery area of 100 m2 is required to transplant 1 ha of land. A 50 cm drainage gap should be maintained in between two nursery beds.

B. Land preparation and fertiliser management

Pebbles and other indecomposable debris should be removed while soil should be finely tilled. Compost manure or well decomposed Farm Yard Manure (FYM) should be added at the rate of 5 to 10 kg/m2 depending upon the soil fertility status. Inorganic fertiliser should be avoided if possible as it accelerates seedling growth making it prone to disease and insect infestation.

C. Seed rate

30 to 40 kg quality seed with more than 80 per cent germination proportion is sufficient for cultivating 1 ha of land. Seed should be treated before seeding in order to avoid seed borne diseases like False Smut and Blast with Bavistin mixed at the rate of 2 to 3 g/l water.

D. Weed, insects and disease management

Nursery bed should be maintained free from weed, insects and diseases by adopting clean cultivation practices. If possible, use of chemical weedicides or pesticides should be avoided. Manual weeding can be done to control weeding and organic pesticides like *Neem* (Azadirachta indica) extract or other homemade organic pesticides can be used if necessary.

3. Transplanting and post transplanting crop management

Usually 25 to 30 days after seeding, seedling becomes ready for transplanting. Delay in transplanting affects tillering potential of the variety. Care should be taken during uprooting of seedling from nursery bed to avoid root damage. Seedling should be transplanted as soon as possible after uprooting.

A. Land preparation

These varieties require plenty of water, so they should be planted in low land with assured irrigation facility. Depending upon the nature and type of soil, one deep ploughing and two cross harrowing with disc harrow are needed. Land should be puddled and levelled before transplanting.

B. Weed management

It is important to control weeds right from the initial stage of rice cultivation that means right from the land preparation phase. Land preparation should be started three to four weeks prior to planting and weedicidesshould be well incorporated into the soil. Here are different stages for weed control:

- Some measures should be taken during the time of transplanting phase. Pre-emergence herbicide Pretilachlor 50 percent EC should be applied by either mixing with sand or water (at the ratio of 1,000 ml/30 kg/ha sand or 1000 ml/500 l/ha water) within 48 hours after transplanting. A total of 0.6 kg should be used within 60 to 65 days after transplanting using Diammonium phosphate DAP amounting 2 to 2.1 kg. During final land preparation, Muriate of Potash MOP weighting 1.5 kg should be used along with = Zinc Sulfate weighting 0.5 to 1 kg. .
- Depending upon the presence of weed, 25 to 30 days after transplanting or active tillering phase, mechanical weeding by Cono Weeder or manual hand weeding can be done. If labour is scarce or wage rate is high, post emergence herbicide can be used alone or in combination with manual or mechanical weeding. Post emergence herbicides like Bispyribac (Nomineegold) at 30 ml/15 l water/Kattha observed to be effective) 2 to 4 D amino salt or ethyl ester (include dose) can be used to control weeds at 3 to 4 leaf stage depending upon the weed type. Flat fan nozzle should be used to spray herbicide. Use of multi nozzle boom sprayer is also good for efficient herbicide spray within a limited time. Herbicide should always be sprayed before top dressing with urea. Herbicides should be carefully sprayed as per the instruction with proper dose for better weed control.
- Booting stage should be same as both the steps above.

C. Irrigation

As these varieties are flood tolerant, they require more moisture compared to other varieties for better production. So, rice field should be continuously flooded or ponded up to 10 to 15 days before harvesting. Continuous flooding helps ensure sufficient water and control weeds. In case of water scarcity, there is range of water saving technologies such as Alternate Wetting and Drying (AWD) which can be applied and critical growth stage should be considered for irrigation. Critical growth stages for irrigation include:

- Active tillering
- Booting
- Heading
- Milking

D. Fertiliser management

Integration of environmental, agronomic and economic aspect of fertiliser management is one of the most important strategies of economic fertiliser management. Recommended dose of fertiliser as a whole is not always right for particular crops in particular context and knowing how much fertiliser to apply can be a difficult task. In this context, it is better to analyse soil tests report and recommend dose of fertiliser required by crop to calculate exact application dose. This not only lowers environmental and health risk but also lowers production cost. In general, Nitrogen (N) is applied in split dose as it does not last for long in soil. It might be lost due to leaching. Also, excess amount of nitrogen can accelerate seedling growth making it prone to insect and diseases. Therefore, depending upon the crop duration of the variety, it should be applied in two to three split doses (Table 2). Half of the required dose of Nitrogen and full doses of Phosphorus (P) and Potassium (K) should be applied at the time of final land preparation before puddling. In case of Zinc (Zn), it should not be mixed with NPK during application but should be applied before or after NPK application.

Table 2 Recommended dose of fertilizers and application time

Fertiliser	Rate Per Kattha[7] (1 kattha=0.0338 ha)	Application Time
Farm Yard Manure (FYM)	400 to 450 kg	During final land preparation
Green Manure/Compost	200 to 250 kg	During final land preparation
Urea[8]	1 to 1.3 kg	During final land preparation
	0.6 kg	20 to 25 days after transplanting
	1 kg	40 to 45 days after transplanting
	0.6 kg	60 to 65 days after transplanting
Diammonium Phosphate (DAP)	2 to 2.1 kg	During final land preparation
Muriate of Potash (MOP)	1.5 kg	During final land preparation
Zinc Sulphate	0.5 to 1 kg	During final land preparation

E. Insect or pest and disease management

Farmers lose an estimated average of 37 per cent of their rice crop to pests and diseases every year. In addition to good crop management, timely and accurate diagnosis of insects, pest and diseases can significantly reduce losses. The best control for pests and disease is to prevent it in the first place.

To limit pest and disease damage followings can be practiced:

- Clean cultivation practice
- Use of healthy and treated seeds and resistant variety
- Planting at the same time as neighbour's
- Adequate application of fertiliser

Encouraging natural enemies in case of pest or disease infestation, Integrated Pest Management (IPM) approach can be used to maintain pest damage below the economic injury level.

7 30 Kattha equals to 1 Hectare

8 In case of flooding, 1.5 KG Urea and 1 KG DAP should be applied 7days after flood water recedes

F. Transplanting

Generally, 25 to 35 days old seedlings are suitable for transplanting. Planting of 1 or 2 seedlings in line spaced at 25 cm (plant to plant) and 25 cm (row to row) gives good results (Photo 3). Planting too many seedlings with closer spacing leads to reduced tillering and ultimately lowered production. For line transplanting, a baseline should be made with the help of rope or string (marked 25 cm apart) and planting should be done following the baseline mark. Line transplanting allows easier intercultural operation like machine weeding and fertilizer or pesticide application.

Photo 3 Line transplanting of Swarna Sub-1 in PPCR Project by PAC

G. Harvesting

It is important to apply good harvesting methods to be able to maximise grain yield, and minimise grain damage and quality deterioration. Harvesting rice consists of the basic operations which can be done in individual steps or in combination using a combine harvester that includes:

- **Reaping**: Cutting the mature panicles and straw above ground
- **Threshing**: Separating the paddy grain from the rest of cut crop
- **Cleaning**: Removing immature, unfilled, non-grain inert materials
- **Hauling**: Moving the cut crop to the threshing location
- **Field drying**: Leaving the cut crop in the field and exposing it to the sun for drying (optional)
- **Stacking/Piling**: Temporarily storing the harvested crop in stacks or piles (optional)
- **Bagging**: Putting the threshed grain in bags for transport and storage

Case-study: Benefiting from flood tolerant rice cultivation

Ram Prasad Chaudhary, a resident of Tikapur-8, Bangaun in Bardiya and had to suffer production loss due to floods every year alike his neighbours. Their low lying land gets submerged under flood every monsoon. Every year, the Chaudhary community lost most of the rice crops to flood.

> "We used to plant local rice varieties like "mansuli" in our land. Our land is low-lying so we suffer from flood every monsoon. Flood usually stays for a week and our rice crop mostly dies. I used to receive only 15 to 20 kg harvest from 6 kattha of land." He further adds, "Our neighbours who grow same variety in the upland not much affected by flood, harvest around 120 kg rice per kattha."
>
> **Ram Prasad Chaudhary** (Local farmer, Tikapur)

Local and most of the improved varieties do not withstand flood for longer duration. These varieties usually die if submerged for a week. Farmers were unaware about flood tolerant varieties like Swarna sub-1 and Samba Mansuli sub-1. These flood tolerant varieties usually withstand flood for up to 15 days.

Chaudhary expressed that he learned a lot During Focus Group Discussion (FGD) at the Farmer Field School (FFS) where they were able to share their problems with agriculture Junior Technical Assistants (JTAs) of Nepal Flood Resilient Project (NFRP).

Chaudhary says, “After multiple discussions, we planned to conduct FFS on flood tolerant rice cultivation. We learned all agronomical aspects of swarna sub-1 practically in our own field. We observed how this variety regenerates after submergence and the final harvest was awesome.”

By the end of FFS, Chaudhary and his neighbours were able to harvest 180 to 200 kg of rice per Kattha.

FFS, a group based learning and demonstration platform has been operated through NFRP project at different periods. Chaudhary participated in eight month long FFS programme that focused on flood adaptive rice farming. Apart from that, the project has also conducted FFS on other themes such as cucurbits cultivation (one year), vegetable farming (one year) and others. Chaudhary is also part of Community Disaster Management Committee (CDMC). After participating and learning from FFS, he along with his community members have established *"Harshit Krishak Samuha, Bangaun"* which is a farmers group that helps farmers share their learning and best practices.

Photo 4 Ram Prasad Chaudhary sharing his learning and experience from FFS

Further information

- http://answers.practicalaction.org/our-resources/item/rice-cultivation-using-alternatewet-and-dry-irrigation-awdi
- http://answers.practicalaction.org/our-resources/item/intensive-rice-cultivation
- http://www.knowledgebank.irri.org/step-by-step-production

Contact for further info

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