Increasing HouseholdFood Security through System of Wheat Intensification (SWI) Technique

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Abstract: Wheat is the number one crop in the Far West region and serves as a major staple in the diet. However, wheat productivity in this region is the lowest among the development regions of Nepal, due to poor quality seed, inappropriate varieties, low seed germination rate, high plant density, and cultural practices.Considering these facts, Mercy Corps Nepal along with implementing partners carried out Participatory Action Research (PAR) with System of Wheat Intensification (SWI) having the overall objective of increasing farmers' productivity with the most practical methods of cultivation. Research results revealed that the wheat variety WK1204 under SWI management yielded 6.52 MT/Hectare,which is almost double the yield with the local variety and practices.The increased wheat yield attainable from 0.25 hectare, which is the average size of land allocation for wheat cultivation in the Far West, can contribute an additional six months of food security for a typical six-member household family.This means that 'Wheat Farming As A Business' can become a profitable agribusiness using these new methods.

Key words: Food Security, Intensification, Participatory Action Research (PAR), System and WK-1204 Wheat seed.

INTRODUCTION

Food security is interlinked with poverty, as there is as direct cause-and-effect relation between them. One of the major reasons underlying poverty in the region is low agricultural productivity (Dahal and Khanal 2010). Nepal's cereal production has not kept pace with the growth in population since the 1960s (GoN, 2010), and Far West Nepal is a seriously food-deficit region which has the lowest wheat productivity with fragmented marginal lands brought under cultivation for subsistence farming.

Wheat is the number one crop in the Far West, serving as one of the major staples in the diet eaten in the form of bread. There has been stagnation in wheat productivity since 2002 in Nepal. The current national average wheat yield is 1,934 Kg/Hectare. In 2007, the National Agricultural Research Council (NARC) has released WK1204 wheat variety to be grown in mid-hills of Nepal, which has an expected productivity of 8 MT/Hectare and is preferred by farmers.

With given constraints of low productivity and fragmented marginal land in use, crop intensification is one of the only alternatives to address the food insecurity problem. Several studies done in the mid-hills have shown that the economy of farmers involved in agricultural intensification has improved (Nani Raut, Bishal K. Situala and Roshan M. Bajrachaya 2010). Among them, the System of Wheat Intensification (SWI) is one of the techniques of wheat

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cultivation to be considered. It is notable for maintaining of 20 cm row and 8 cm plant distances apart. This kind of sowing allows for sufficient soil aeration, moisture, sunlight, and nutrient availability, leading to proper root system development from the early stages of crop growth (ATMA, 2008).

MATERIALS AND METHODS

Mercy Corps Nepal (MCN) intervenes in agriculture to increase the productivity and profitability of smallholders. For the effectiveness of the program implementation, MCN adopts the framework of 'Participatory Action Research' (PAR, 2011) for testing technologies before scaling up and promotes 'Farming As A Business' (FAAB, 2010) for commercial orientation of smallholders.

Survey

A web-based search was done for wheat technology which resulted in learning about the availability and use of SWI in many countries. The team visited NARC's Doti research station and consulted with experts before launching its own evaluation with farmers.

SWI Package

Existing wheat cultivation practices were assessed based on the following four factors known to contribute to low yields – variety, low seed germination, plant density, and crop cultural practices.

Site Selection

For the first year (2009/10), only four sites were involved in the PAR evaluation. In the second year (2010/11), it was conducted in sixteen sites of three working districts in collaboration with the District Agriculture Development Offices (DADOs) there. This year (2011/12) PAR is being conducted in eight sites.

Training

Farmers were trained on two aspects – first, SWI vs. local practice; and second, commercial aspects of 'Wheat Farming As A Business'.

Testing

Primed seed was sown in $50m^2$ areas for each plot/treatment. Manure was applied @15 MT/Hectare to all treatments, while seed rate was maintained @30 Kg/Hectare for T1 treatments, 80 Kg/Hectare for T2 and T3 treatments, and 120 Kg/Hectare for T4 treatment. Weeding and irrigation were carried 3 times in each plot.

RESULTS AND DISCUSSION

With the overall objective of increasing the wheat yield, Mercy Corp Nepal (MCN) conducted Participatory Action Research (PAR) on the System of Wheat Intensification (SWI) in four working districts of Far West region from 2009/10 and 2010/11 and still continuing in this year 2011/12.

SWI Technology Package: SWI practices are not difficult for farmers to understand and adopt compared to their present methods of cultivation, but there is a very great difference between line sowing and the broadcasting methods now in use. Priming seed is not an unknown practice, but

doing this systematically is recognized as something different. The change in cultivation most difficult to get accepted is to reduce plant density dramatically in order to get higher output; it is believed, mistakenly, that sowing more plants will necessarily give more yields. When these respective changes are made together, farmers see this as a new package of practices that they can compare with their usual methods.

Wheat Variety: The participating farmers were very much impressed with WK1204 wheat variety with its bold appearance, amber color, and appearing similar to local wheat grain. Because what matters to them ultimately is the taste, it is important that the new variety is similar to local wheat in taste. This is the first reaction of farmers about WK1204 wheat seed. A literature review about WK1204 variety (SW89.3064/Star) revealed it as one of the most preferred wheat varieties by farmers in Nepal and was officially released to cultivate in mid-hills of Nepal in 2007. There was high demand of seed by neighboring farmers, and it was found that many of the local farmers made advance booking for seed from the farmers who were growing it. Almost all seed was reserved for next year's wheat cultivation in the locality.

Seed Priming: Distinctly, the primed seed had early and uniform germination as noticed by the farmers, which had given them confidence for good plant establishment at the early stage. None of the farmers had practiced seed priming in the past. So they realized the merit of investing in seed priming materials. Seed priming had a significant effect on tiller number. Wheat grown on seed-primed plots had more tillers than in non-primed plots. Overall, the seed priming had a direct effect on reduced seed rate because it ensured germination with minimum losses from birds and ants.

Plant Density: SWI research results suggest that maintaining controlled plant density is the most crucial part in wheat cultivation. Most of the SWI recommendations are to maintain 20 cm row-to-row x 8 cm plant-to-plant distance with 2 seeds per hill in 2-3 cm depth planting. It is only possible to maintain plant density by line sowing. In this trial, line sowing was done manually which was found very tedious and cumbersome to large-scale cultivation. Simple line sowing seed drillers are available for cultivation in the plains. Discussion has just started to design and test manual wheat seed driller for hill conditions which should be women-friendly too.

Line sowing has very impressive results:

a. Higher number of tiller with increased number of spikes and greater lengths
b. Number of grains per spike was significantly higher, i.e., 75 per spike in T1 compared to 44 per spike in T4.
c. ‘Days to maturity’ was higher in primed plots compared to non-primed plots and highest with line sowing.
d. 1000 gm weight of wheat grains was highest for T1 and lowest for T4. Maturity was delayed in primed plots, resulting in a longer grain-filling period, which in turn resulted in heavier grains compared to non-primed plots.
e. Plant height was more or less equal in all treatments, but the number of tillers differed significantly, and so did the length of the spikes in the case of T1 and T4.
f. There is almost double yield increase in the case of SWI treatments as compared to local practice.

Cultural Practices: All the crop cultural practices recommended under SWI technology were assessed by participating farmers. They liked the variety very much; seed priming was new, but was found to be very useful in maintaining early and uniform germination; line sowing was the most tedious practice which needs to be replaced by manual seed driller if possible to make the system more women-friendly; and other crop cultural practices like thinning and gap filling were okay. Manual weeding was easy in the case of line sowing compared to broadcasting, but still tedious though useful. Use of a cono-weeder has given satisfactory results in India and Nepal Terai, and it can be replicated in the hills as well.

Yield and Profitability: With the adoption of SWI technology, farmer can increase yield by more than 156 Kg per 0.05 Hectare of land. In the Far West, average land holding has about0.25 Hectare available for wheat cultivation, so if a farmer adopts SWI in 0.25 Hectare of land, there will be increment of wheat more than 780 Kg, which will be sufficient food for a 6-member household @ 4 Kg/day consumption wheat for more than 6 months as per the 2010 standard set by Rural Community Infrastructure Works (RCIW) in the Food for Work programme, Government of Nepal.

While directly addressing the issue of food security at household level, 'Wheat Farming As A Business' seems to open possibilities for profitable agribusiness as compared to local practices once the required inputs like seed, seed priming materials, and technical services are linked with market-based solutions in the long run. Finally, SWI is useful to the small, marginal and landless farmers who can lease their land, and it pays attentions for intensive care with surplus labor. So it is 'growing more with less' (Gujja and Thiyagarajan, 2010).

CONCLUSION

The study shows that wheat crop responds positively to seed priming, line sowing, and wider spacing. The wheat variety WK 1204 is highly productive compared to the local variety and is suited for the climate of the mid-hills. Reduced plant population (with increased spacing of plants 20cm x 8cm) is crucial for increasing the number of tillers per plant, plant height, and spike length, as well as the number and size of grains, all of which result in higher grain and biomass yield. SWI management used on 0.25 Hectare of land with improved variety, seed priming, line sowing,and wider spacing can increase yield by as much as 100%, which can contribute for adding 6 months of household food security assuming a six-member household. Based on empirical results, it can be said that-

1. SWI technology is very suitable to marginal farmers working under Nepal hill conditions.
2. The tediousness of line sowing and weeding can be minimized by introducing simple manually-operated seed-drillers and cono-weeders.
3. If improved seed is available, then seed priming with broadcasting method can also increase crop yield.
4. Use of farm yard manures (FYM) and other organic matter are vital for maintaining the soil fertility status of cultivated land.
5. Commercial orientation of 'Farming As A Business' (FAAB) training should ensure input availability at local level for long-term sustainability of the production system.

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REFERENCES

ATMA (2008) Assessment, Refinement and Validation of Technology through System of Wheat Intensification (SWI) in Nalanda: Final Report.Agriculture Technology Management Agency (ATMA), Nalanda, with assistance of PRADAN, Nalanda, Bihar, INDIA (krishi.bih.nic.in/SWI_Final_Report.pdf)

CIIFAD SWI website: http://sri.ciifad.cornell.edu/aboutsri/othercrops/wheat/index.html Cornell International Institute for Food, Agriculture and Development

Dahal, H. and D.R. Khanal (2010) Food Security and Climate Change Adaptation Framework: Ministry of Agriculture and Cooperative (MoAC), Government of Nepal, www.moac.gov.np

FAAB (2010) Farming As A Business. Mercy Corps Nepal- http://nepal.mercycorps.org

FAO Website – System of Crop Production Intensification:http://www.fao.org/agriculture/crops/core-themes/theme/spi/en/

Food Price Crisis Trust Fund (2009) Rural Community Infrastructure Works Guidelines, Government of Nepal (GoN), Rural Community Infrastructure Development Programme, Central Programme Assistance Unit, Ministry of Local Development, Pulchowk, Nepal

GoN (2010)Nepal Food Security Enhancement ProjectProposal for Global Agriculture and Food Security Programme (GAFSP) Unit, Government of Nepal, Ministry of Finance, September 2010

Gujja, B.and T.M. Thiyagarajan (2010) Producing more with less: exploring farm-based approaches to improve productivity and providing options to farmers in adapting to climate change. In: Wassman R, editor. *'No Regret' Options for Adaptation and Mitigation and their Potential Uptake*. IRRI Limited Proceedings No. 16. Los Baños (Philippines): International Rice Research Institute. p 1-8.

Ortiz-Ferrara, G. et al. (2007) Partnering with farmers to accelerate adoption of new technologies in South Asia to improve wheat productivity, Euphytica (2007) 157:399-407, DOI 10.1007/s10681-007-9353-2

Mercy Corps Nepal (2009). SWI Implementation Guidelines, Safety Nets supporting Agriculture Productivity (SNAP), Mercy Corps Nepal, Sanepa, Kathmandu

Nani Raut, Bishhal Kumar Sitaula and Roshan Man Bajrachayra (2010), Agricultural Intensification: Linking Livelihood Improvement and Environmental Degradation in the Mid-Hills of Nepal. The Journal of Agriculture and Environment Vol: 11, Jun.2010. Review Paper

NARC (n.d.) National Wheat Research Program, Bhairhawa, National Agricultural Research Council of Nepal Website: http://www.narc.gov.np/

NARC (2007) New Wheat Variety Released, NARC Newsletter, Vol. 14 No.3, National Agricultural Research Council, Kathmandu

PAR(2010) Participatory Action Research (PAR) in Agriculture,Mercy Corps Nepal, Sanepa

PSI(2009), SWI – An Innovation. People's Science Institute, Dehradun, India:http://www.peoplesscienceinstitute.com/SWI.html

Styger, E. and H. Ibrahim (2009) The System of Wheat Intensification (SWI), First-Time Testing by Farmers in Goudam and Dire, Timbuktu, Mali 2009, USAID, and Africare Mali, Bamako(http://sri.ciifad.cornell.edu/countries/mali/Mali_SWI_Africare09.pdf)

Thapa, T. (2010) A Report on Value Chain Analysis for High-Impact Cropping Pattern Selection, SNAP Project site in Far West Region of Nepal, Mercy Corps Nepal, Sanepa.

WEF (2010) Realizing a New Vision for Agriculture: A Roadmap for Stakeholders, World Economic Forum, McKinsey & Company, Geneva, Switzerland – www.weforum.org

Table 1: Comparison of Local vs. SWI Practice

SN	Parameters	Existing method	System of Wheat Intensification
1	Seed required	6-10 kg	1-2 kg
2	Seed treatment	Not done	Done with hot water, cow urine, compost, and bavistan
3	Method of sowing	Broadcasting	Dibbling in line
4	Spacing	No proper spacing	20x20 cm.
5	Hoeing and weeding	Not done	1st weeding after 20 and 2nd after 30days after sowing (DAS)
6	Panicle length	10-11cm	15 cm.
7	No. of grains/panicle	18-50 grains	60-120 grains
8	No. of panicles/hill	Mostly 1-2 in a good stand with 2-4 panicles per hill	20-45 per hill from single plants
9	Germination of seed in the field	A week after sowing	Within 2-3 DAS
10	Leaves	Thin, less leaf area index	Broad, more leaf area index
11	Stems	Thin	Thick
12	Roots	Shallow	Deep (up to 20-25cm) and weeds grow because of space
13	Irrigation requirements	2-4	4-5
14	Yield	3-10quintals per 0.05 hectare	25-50% more, i.e., 4-15 quintals per 0.05 hectare

Table 2: Participatory Action Research (PAR) Sites

District	PAR sites		
	Year 2009/10	Year 2010/11	Year 2011/12
Baitadi	-	4	4
Dadeldhura	2	4	-
Doti	-	8	4
Kailali	2	-	-

Table 3: List of Different Treatments Applied

SN Treatments

1. T1 – Seed priming + Line Sowing
2. T2 – Seed Priming + Broadcasting
3. T3 – No Seed Priming + Broadcasting
4. T4 – Control (Local Seed + Local Practice)

Table 4: Plant Growth Parameters

SN Parameters

1. Plant height in centimeters (cm)
2. Number of tillers per plant
3. Length of spike in centimeters (cm)
4. Days to maturity
5. Number of grains per spike
6. 1000-grain weight in grams (gm)
7. Grain yield in kilograms (Kg) per Hectare

Table 5: YieldAttributesof WK1204 Wheat Variety

SN	Treatments	Plant height (Cm)	# of tillers per plant	Length of spikes (Cm)	Days to maturity	No. of grains /spike	1000-grain weight (gm)
1	T1	88.5	14.35	9.21	157	74.95	62
2	T2	88.1	11.25	8.91	153	69.60	58
3	T3	79.8	3.05	6.90	145	53.20	52
4	T4	89.2	2.01	5.80	135	44.30	48
	CV%	0.66	8.99	3.19	1.19	2.52	2.7

Table 6: Enterprise Budget –Local Methods (0.05 Hectare)

Items	Local			
	Unit	Qty	Unit Price	Total Cost (NRs)
INPUTS				
-Labor	Days	3	400	1,200
-Draft	Days	2.6	500	1,300
-Materials	Kg			
a) Seed		8	40	320
b) FYM		700	0.5	350

Total Cost				3,170
OUTPUTS				
Grain yield Straw yield	Kg Kg	170 600	40 2	6,800 1,200
TOTAL RETURN				8,000
NET PROFIT				4,830

Table7: Enterprise Budget – SWI Methods (0.05 Hectare)

Items	Local			
	Unit	Qty	Unit Price	Total Cost(NRs.)
INPUTS				
-Labor -Draft -Materials a) Seed b) FYM c) Jaggery d) Plant protection	Days Days Kg	7 3 - 2 1,000 1 0.01	400 500 50 0.5 100 1,000	2,800 1,500 100 500 100 10
Total Cost				5,010
OUTPUTS				
Grain yield Straw yield	Kg Kg	326 900	40 2	13,040 1,800
TOTAL RETURN				14,840
NET PROFIT				9,830

Table 8: Grain Yield of WK1204 under SWI techniques

SN	Treatments	Grain yield (Kg/Hectare)
1	T1- Seed priming + Line Sowing	6,516.00
2	T2- Seed Priming + Broadcasting	4,524.70
3	T3 - No Seed Priming + Broadcasting	3,738.00
4	T4 - Control (Local Seed + Local Practice)	3,405.00
	Grand Mean	4545.56
	F-Test CV%	* 1.37