NARC/PNARD Wheat Trials on Regenerative Agriculture Production System in Pakistan

(2021-22)

1. Regenerative agri-production system (RAS) has been practiced in Pakistan for the last few years under various names the most known as PQNK started by Mr. Asif Sharif, however no formal authentic validation of results and impacts have been conducted.
2. National Agriculture Research Council (NARC) Islamabad in collaboration with the Pro Nature Alliance Research & Development (PNARD- https://pnard.com/) planned, designed and conducted a series of field trials on various crops including the wheat to test the proof of concept and validate the Regenerative Agri- production system (RAS). To develop the proof of concept of RAS, experts from NARC and PNARD developed a standardized package of RAS, and compatible machinery including a precision seed planter.
3. The trials have been continued from 2020 on public and private farms in different agroecological and cropping zones. Under the RAS package, hard pan is broken, no-tilling is done, sowing is done on raised beds with a pneumatic precision planter covered with organic mulch (rice or wheat straw). Little to no chemical fertilizer is used (based on the soil's mineral & organic matter), nor are pesticides and or weedicides used. This RAS package has been tested on-station at NARC, Islamabad, and seven provincial govt adaptive research farms in Punjab and on several private sector farms in Punjab and Sindh for the wheat crop.
4. **Farmers Practice**: Majority of wheat farmers broadcast seed by hand and use about 50 kg seed/acre. Progressive farmers use seed drill with about 40 kg seed/acre. Both use different levels of fertilizers and other chemicals and irrigations. In the trials, these two types of practices have been included to compare with the RAS.
5. In 2021-22 (2nd year wheat trials), three treatments were sown as shown in Table 1, whereby T1 consists of the standardized RAP system, and T2 and T3 consist of the best current farmer practices in Pakistan, where seeds are sown on flat land with drill/ broadcast with the use of all inputs (fertilizer, pesticides, and weedicides). Three plots of 3 acres each, with similar dimensions, were sown for each treatment on 6 December 2021 with the ***Borlaug- 2016*** variety of wheat[1].
6. In T1, the hard pan was broken (a one-time activity for at least five years), and sowing was done on 42-inch raised beds with 18-inch water furrows[2]. A locally manufactured pneumatic multi-crop precision wheat seed planter was used for the trial. As per specifications developed by the PNARD/NARC experts, 5kg[3] of wheat seed was added to the planter, out of which 4.24kg seed was consumed, and the rest was left, reflecting that the precision was around 80 %. The same was confirmed when the germination rate was about 80% for T1. In T1, organic mulching was undertaken with rice straw, but chemical fertilizer, pesticide & weedicide was not used.
7. In T2, and T3, an equal quantity of pesticide, fertilizer, and weedicides were used. All three treatments were provided with equal water, once by flood irrigation and twice through rainfall during the crop cycle.

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[1] Previously, oats were planted in these fields with the regular use of fertilizer and chemicals.

[2] 42 inch was selected as the size of the raised beds as it is the space between the two tires of the tractor that is most common in Pakistan. The space under the tractor tires forms the 18-inch water furrows, where water is retained due to soil compaction. In this manner, 68% of the total area is taken up by raised beds and only 32% is taken up by water furrows immediately leading to a 68% decrease in water usage versus flood irrigation on flat land.

[3] This was based on 9x9 inch row to row and 5x5 inch seed to seed distance, total number of seeds required is 96,000 seeds per acre.

Table 1: RAPS Trials Treatments at NARC, Islamabad.

Treatment	Hard Pan	Tillin g	Raised Beds/Flat	Sowing with Pneumatic Precision Planting/drill /Broadcasting	Seed Usage/ Acre	Organic Mulching	Inputs (Fertilizer, Pesticides, Weedicides)
T1-RAPS package	Yes	No	Yes- 42 inch	Yes (80% precision)	4.24 kg	Yes	No
T2-Farmer practice with drill	No	Yes	No- flat	seed drill (90% precision)	40 kg	No	Yes
T3-Farmer practice/br oadcasting	No	Yes	No- flat	Broadcasting	50 kg	No	Yes

RAS Wheat sowing matrix

Seed Rate at 42" Wide Beds (9"x5" Grid Size) for wheat

Parameters	Values	Units
Area of one acre (220'x198')	43,560	ft2
Bed width	42	in
Furrow centre to furrow centre distance (track width of tractor)	64	in
Number of beds in the width (lengthwise)	37.13	No.
Number of exact beds	37	No.
Number of rows at 9" distance	5	No.
Row to row distance	9	in
Plant to plant distance	5	in
Length of one row of 220'	2,640	in
1000 grain weight (average)	45	g
Number of plants in 1-row	528	No.
Number of plants in 5-rows of 1-bed	2,640	plants
Number of seeds or hills in all 37 beds	97,680	No.
Seed rate per acre	4.40	kg/acre
Number of tillers per seed (estimate of LUMS)	35	No.
Number of grains per panicle (average)	16	No.
Number of grains per acre (37 beds, 5-rows)	54,700,800	g
Total grain weight	2,461,536	g
Total grain weight	2,461.54	kg
Yield (maunds/acre)	61.54	kg/acre

Table 2: Results of the NARC Wheat Trial

Treatments (T)	Plant Height (Cm)	Spike Length (Cm)	Spikelet's (#)	Avg # of Tillers (#)	1000 Grain Weight (g)	Yield/ Acre (Mounds)	Cost of Production/ Acre (PKR)	Income /Acre (PKR)	Profit Margin/ Acre (PKR)
T1	94.5	12.6	22.3	29	47.5	46.65	11,660	111,960	100,300
T2	96.6	10.3	18.4	3.8	44	42.34	26,236	101,616	75,380
T3	98.5	9.9	18.8	3.42	43.5	43.50	22,036	104,400	82,364

8. Table 2 lists the results of the wheat trials; we can see that the spike length, the number of spikelet and the weight of each grain in T1 is significantly greater than that of T2 and T3. A significant result of the trial is that under the RAS in T1, a maximum of 86 tillers/seed were counted, while the average was 29 tillers per plant. This was significantly higher in comparison to all the other treatments. Even with 85% precision in T1 (4.24 kg of seed/ acre), the yield difference was significant compared to T2 and T3 (50 kg of seed/ acre), where a seed drill with 90% precision and broadcast method was used
9. The cost of production in T1 was almost half that of T2 & T3, while the profit margin of T1 was highly significant with T2 and T3, even with 80% precision.
10. Projections were also made under a scenario of enhanced precision. If precision is enhanced to 90%, the yield and farmer's profits under T1 are much higher than those under T2 and T3. It is important to note that despite not using any pesticide or weedicides in T1, there was no incidence of pest attack, and minimal weeds were seen.
11. Based on the problems experienced and lessons learned during the on-station wheat trial, the consortium of PNA and NARC developed a multi-seed pneumatic precision planter. The planter was tested on-station and on-farm and had a proven 100% precision. The planter also has a built-in mulcher that can convert stalks leftover after harvest into organic mulch for the field. The planters were then provided to four different farms by PARC/ PNA in Sindh and Punjab. These farms planted maize, cotton, moong, and fodder grasses using RAS. To date, interim results have revealed 100% precision for the planter and excellent germination ratio, plant size, vigor, and health under the RAS.
12. **World Bank Field Survey**: Climate Smart Agriculture (CSA), is being practiced by farmers in Punjab and Sindh for the last few years for different crops under the name of PQNK and Climate Smart Agriculture (CSA). However, still there is a lack of a standardized package of practices and technologies and credible evidence of impact and adaptation at the farmers' level.
13. To overcome this, the World Bank, in collaboration with the Planning Commission of Pakistan, initiated a quantitative and qualitative survey of farmers to assess the current state of CSA. Under the qualitative survey, fifty-five (55) farmers in Punjab and Sindh were interviewed.
14. The survey studies revealed that overall, farmers lacked awareness of the science behind regenerative agriculture and its benefits. Farmers were also unaware that transforming to CSA/PQNK/RAS was a gradual process based on organic matter, not a sudden or overnight process. The regenerative practices of raised beds, mulching, and precision planting had widescale adaptation amongst farmers. Other RAS/PQNK practices, namely hard pan breaking, no tilling, pneumatic precision planting, low to no fertilizer use (depending on soil organic matter), and no chemical usage, had little adaptation amongst farmers as a package.
15. Other than Pedaver and PNA in the private sector, there is a lack of a credible public sector organization providing technical support, training, and guidance to farmers on RAS/PQNK/CSA. Most of the farmers interviewed had adopted these practices based on anecdotal evidence and by seeing the results of other farmers. Farmers could also not access machinery (organic mulcher, pneumatic multi-seed precision planter, raised bed maker, hard pan breaker) compatible with RAS/PQNK/CSA, particularly on a rental basis.
16. To ensure adoption by farmers, there is a need to develop a standardized package of practices and technologies adaptable to the soil physiology and cropping pattern of different agro-ecological zones in Pakistan. Strong research and development through randomized and cluster-based piloting/ propagation and credible impact assessments also need to be conducted. It is also essential that the data on the benefit of RAS/CSA be disseminated to farmers in an easy-to-understand manner. Farmers need to be trained on RAPs based on three main principles: seeing is believing, learning by doing, and

adapting by demonstrating profits. For propagation, farmers and farm laborers need to know the benefits of RAS/PQNK/CSA and proper usage techniques. Efforts must be undertaken to ensure that machinery compatible with RAS/PQNK/CSA is available on a rental basis. There is also a need to develop harvesting machinery compatible with RAS/PQNK/CSA of sowing on raised beds.