Global Scientific JOURNALS

GSJ: Volume 8, Issue 7, July 2020, Online: ISSN 2320-9186

www.globalscientificjournal.com

# Economics of Wheat Production with Happy Seeder in Rice-Wheat Cropping System of Punjab, Pakistan

Muhammad Tahir Latif[1*], Muzzammil Hussain[2], Naeem Faisal[1], Sami Ullah[1], Usman Zafar[3], Muhammad Hamid Rafiq[4], Afif Ur Rehman[5], Muhammad Asghar[1], Iftikhar Ahmad[1], Majid Hamid[1] and Imtiaz Hussain[6]
[1]Adaptive Research Farm, Gujranwala 52200, Pakistan
[2] Directorate of Agriculture (FT & AR) Gujranwala 52200, Pakistan
[3]Assistant Director Agriculture (OFWM) Lawa district Chakwal
[4] Agricultural Extension Gujranwala 52200, Pakistan
[5] Site Engineer, Anchor commodities (pvt.) Ltd. Lahore
[6] Crop Science Institute, National Agricultural Research Council, Islamabad 44000, Pakistan
[*]Corresponding author: tahirr.uaf@gmail.com

## ABSTRACT

Adoption of zero tillage (ZT) with Happy Seeder (HS) is needed in rice-wheat cropping system for timely field operations and sowing of wheat. A survey was conducted in agro-climatic zone of Gujranwala (rice-wheat system) after harvesting of wheat crop 2018-19 to estimate the economics of wheat production with HS as well as to record the farmer's perception regarding its adoptability. Convenience non-probability sampling method was employed with a sample size of 100. In the studied area HS was adopted on 16.59% of total wheat cultivation area. Adoption of HS facilitated farmers to sow wheat about 10-15 days earlier than conventional tillage (CT) broadcasting method; the maximum of wheat sowing (53%) with HS was recorded between 15$^{th}$ to 30$^{th}$ November. The Yield, Net benefit and BCR were higher by 7.14, 15.91% and 29.10%, respectively with HS sowing primarily due to reduction in operational cost by 18.6% than CT. Sowing of wheat with HS lead to savings in cost incurred on land preparation (100%), seed (7.18%), irrigation (12%) and fertilizer (11.67%) in comparison to CT method. In conclusion, zero tillage with HS is the solution for timely wheat sowing and saving of operational cost as farmers are reluctant to prepare fine seed bed for sowing of wheat; hence it could be adopted for uplifting of wheat production and economic growth.

**Keywords**

Adoption; Economics; Happy Seeder; Rice-wheat cropping system; Zero tillage

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is a staple food in most of the countries worldwide. It contributed 8.9% of the value added in agriculture and 1.6% share of Pakistan's GDP (GOP, 2019). Wheat is cultivated in various cropping systems such as rice-wheat, maize-wheat, cotton-wheat and sugarcane-wheat in Punjab, Pakistan. Rice-wheat and cotton-wheat contributed about 60% of the wheat area in the country. In Pakistan wheat sowing starts from October and continues till the mid of January (Farooq *et al.* 2007). In rice-wheat cropping system late maturity of the fine rice (i.e. Super Basmati) delays wheat sowing. The wheat sowing may more be late because of pre sowing irrigation (*rauni*) followed by seedbed preparation, which required further 7-10 days depending upon the climatic conditions and prevailing field capacity in winter. Delay in wheat sowing from 3$^{rd}$ week of November has progressively reduced grain yield (Iqbal *et al.* 2017). Due to higher inputs cost and labour scarcity for growing of crops, the farming community is in the need of sustainable, economical and time saving alternative sowing methods.

The Happy Seeder (HS) is a tractor mounted machine that cut and picks up rice straw, sows wheat in bare soil without seed bed preparation, and spreads the straw over the sown area in between lines as mulch. Happy Seeder cuts the loose or standing stubbles and straw in front of the sowing tine and clean each tine twice in one rotation of rotor for appropriate seed placement in soil with its attached zero-till drill. In this case, the resulting mulched rice residues are less likely to cause immobilization of N, conserve soil moisture, improve organic matter and suppress weeds which could improve wheat yield (Singh *et al.* 2009). Bhushan *et al.* (2007) explained that the crop is cultivated with ZT drill in the residual moisture for saving of time and land preparation cost in rice fields irrigated in second fortnight of October. Moreover, due to ZT in wheat, saving of input cost and irrigation water had been estimated.

Zero tillage (ZT) seems to be adopted initially by the well endowed farming community. Dissemination of ZT on rent charges has been recorded. Time and resources saved through ZT may be utilized by farmers for other productive and social purposes; resulting in enhancing farmers' livelihood. Initially the ZT has disseminated more widely in the better endowed farming areas. ZT mainly has an environmental positive effect (fuel and water saving, reduced greenhouse gas emission). The irrigation water saving in the wheat is principally interesting keeping in view of excessive groundwater misuse in intensive rice-wheat cropping pattern. However, leaving more rice straw as mulch has implication for operation of ZT drill as well as trade-off between residue use for livestock feed and conservation agriculture (Erenstein *et al.* 2007).

For optimum sowing time with desired inputs, reduce in land preparation cost various farmers are adopting resource conserving methods like zero tillage with HS and line sowing of wheat. Hence the present research study was planned to compare the economics of wheat production with HS to CT method of broadcasting and record the perception for adoption as well as non-adoption of HS by farmers to give some policy recommendation.

## MATERIAL AND METHODS

Field survey was conducted for primary data collection after harvest of wheat crop 2018-19 in agro-climatic zone of Gujranwala (rice-wheat system); due to intensive cultivation of rice as major crop in Kharif season and wheat as major crop in Rabi season. Gujranwala zone comprises of six districts namely Gujranwala, Gujrat, Hafizabad, M.B.Din, Narrowal and Sialkot. Happy Seeder (HS) for zero tillage has not been adopted on large area to find out HS adopters accessibly. Therefore the list of farmers/trials for demonstration and evaluation of happy seeder (HS) for wheat sowing under (Agriculture Innovation Program) AIP project was collected from Adaptive Research Farm, Gujranwala. Also record of buyers/adopters was got from manufacturers based in Daska city. About 50 farmers with adoption of HS were included in sampling frame. The same number of non-adopters was interviewed from the same locality/site of HS adopters for comparative analysis. Convenience non-probability sampling method was employed keeping in view the time and cost constraint to select the respondent farmers with a sample size of 100. Pre-tested questionnaire was used for data collection. The reasons for adoption as well as non-adoption of HS were also recorded. Benefit cost ratio (BCR) and Net benefits was computed to compare the economics of wheat production with HS to conventional tillage (CT) broadcasting method according to the approach employed by Younas *et al.* (2016) and Latif *et al.* (2017). The net benefit was calculated by using the formula;

$$Net\ benfit = Gross\ incom - Total\ cost$$

The benefit cost ratio (BCR) was calculated by using the following formula (CIMMYT, 1988);

$$BCR = \frac{Gross\ incom}{Total\ cost}$$

## RESULTS AND DISCUSSION

### Socio-Economic Factors

The average age (year) and education (schooling year) of respondent farmers were estimated at 41.50 and 8.06, respectively. The average land holding size was recorded as 4.66 ha while prevailing land rent was found as 92.45 thousand Rs $ha^{-1}$. Wheat was cultivated on 77.33 ha with HS (16.59% of total wheat cultivation area); while 388.66 ha was estimated with CT broadcasting method. Regarding ownership of farm assets it was estimated that in studied area the 62% farmers had their own tractors and cultivators; 16% had rotavator, 13% had disk harrow, 25% had *karah*; while, only 5% farmers owned happy seeder and laser land leveler, respectively. Turbo seeder, seed cum fertilizer drill, zero till drill and Happy seeder had been used by farmers in rice-wheat cropping system from time to time. Due to some issues and constraints all the ZT machines had been abandoned by farmers in the study area except the happy seeder. In studied area, the soil type was estimated as sandy (16%), clayey (49%) and clayey loam (35%) and source of irrigation was recorded as canal (15%), tubewell (75%) and combined (10%). Pertaining to varietal adoption it was recorded that farmers had adopted the varieties (%) as Faisalabad 2008 (77%), Galaxy 2013 (6%), Ujala 2016 (5%), Punjab 2011 (3%), Lasani 2008 (3%), Sehar 2006 (3%) Gandam-1 (1%) and Anaj 2017 (1%).

### Effect on Sowing Time

It was estimated that adoption of HS facilitated farmers to sow wheat about 10-15 days earlier than CT method. The comparison of sowing time between CT and ZT with HS methods showed that the maximum of wheat sowing (53%) with HS was recorded between 15$^{th}$ to 30$^{th}$ November. However, maximum wheat sowing (40%) with CT was recorded on 01$^{st}$-10$^{th}$ December (Table 1).

After 20$^{th}$ November wheat yield potential decreases by 1.5% per day as terminal heat implies (Hobbs and Gupta, 2003). However, HS resulted in timely sowing, lowers land preparation cost and increases net returns. 4-6 ploughing and 2-3 planking operations are comparatively common in fine textured soils ensuring in enhancing planting cost and delay in wheat sowing. Malik *et al.* (2002) concluded that wheat sowing was possible by saving 8-25 days in Bihar and 7-10 days in Haryana through HS.

**Table 1: Comparison of Wheat Sowing Time (% Area)**

| Sowing time | Conventional Tillage | Zero Tillage with Happy Seeder |
|---|---|---|
| Before 15$^{th}$ Nov. | 3 | 0 |
| 15$^{th}$ Nov-30$^{th}$ Nov | 11 | 53 |
| 01$^{st}$ Dec-10$^{th}$ Dec | 40 | 26 |
| 11$^{th}$ Dec-20$^{th}$ Dec | 29 | 15 |
| After 20$^{th}$ Dec | 17 | 6 |

### Effect on Land Preparation and Input Use

In present study, the tillage/land preparation cost was estimated as 13.76% of the total operational cost in CT wheat sowing. The land preparation operations for wheat sowing decreased from an average of five to one only in zero tillage with HS. Similarly, previous studies have reported up to 12 hr. $ha^{-1}$ of tractor operational time saving in HS (Sharma *et al.* 2002). In present survey, it was recorded that 7.73% less seed was required in ZT thus reducing seed cost by 7.18% than CT (Tables 2, 3). Mishra and Singh (2012) explained the seed broadcasting for seed placement at different depths resulted in poor stand establishment and requirement of high seed rate. Tahir *et al.* (2008) observed that seed rate was almost same in both HS and CT methods. Furthermore, Sidhu *et al.* (2007) concluded that the HS is about 50% economical in crop establishment in comparison to CT practice. Moreover, in present survey, the saving of Urea and DAP fertilizer (kg $ha^{-1}$) estimated as 9%, and 11.11%, respectively, through adoption of HS; therefore, 11.67% reduction in fertilizer cost

was recorded (Table 2). According to Laxmi *et al.* (2007) some ZT adopters reported 20 kg $ha^{-1}$ fertilizer saving.

In present study, 6.66% less number of irrigations was recorded with HS and 2.23% less time consumed for irrigation with HS than CT. Moreover, the cost incurred for irrigation was decreased by 12% in HS than CT (Tables 2 and 3). According to Raju *et al.* (2012) on an average, farmers saved 6.13%, 15.98%, 45.88% and 13.93% cost on fertilizer, irrigation, machine labour and human labour respectively in ZT than CT of wheat cultivation. According to Iqbal *et al.* (2002) the time (hours) involved to irrigate wheat (particularly during the first irrigation) varied much in different sowing methods. It consumed 2.5, 4 and 3.5 hours respectively to irrigate one acre of wheat cultivated with ZT, *rauni* and *wadwatter* methods. Because with HS it became possible to sow wheat just after rice harvesting through utilizing residual moisture for wheat germination. Moreover, due to water conservation in soil by rice residues which act as mulch the number of irrigations/depth of irrigation is reduced resulting in water saving.

Hence, ZT resulted in irrigation saving when farming community depend on lift irrigation. The problem of wheat plants yellowing after the first irrigation and water logging is there by reduced (Laxmi *et al.* 2003). Tahir et al. (2008) claimed water saving (2 acre inch) and water use efficiency (13% higher) with HS, as compared to CT practice.

**Table 2: Inputs and Output Estimation in Wheat Production**

| Particular | Conventional Tillage | Zero Tillage with Happy Seeder | % change |
|---|---|---|---|
| Seed (kg $ha^{-1}$) | 129.06 | 119.80 | -7.73 |
| Urea (kg $ha^{-1}$) | 148.20 | 135.85 | -9.09 |
| DAP (kg $ha^{-1}$) | 123.50 | 111.15 | -11.11 |
| Potash (kg $ha^{-1}$) | 30.88 | 30.88 | 0.00 |
| Diesel consumption (L $irrigation^{-1}$) | 22.60 | 21.30 | -6.08 |
| *Tubewell Irrigation (No./ha) | 1.50 | 1.40 | -6.66 |
| Tubewell time consumed (hrs. $irrigation^{-1}$) | 7.69 | 7.52 | -2.23 |
| Wheat yield (t $ha^{-1}$) | 3.90 | 4.20 | 7.14 |
| *Bhoosa* yield (t $ha^{-1}$) | 3.40 | 3.30 | -3.03 |

*Less no. of irrigations was recorded due to rainfall



**Effect on Yield and Economic Benefits**

Higher yield (4.2 t $ha^{-1}$) was estimated with HS as compared to CT (3.9 t $ha^{-1}$) with 7.14% increase in rice-wheat cropping zone. The 15.91% more net benefit was recorded by HS with higher BCR (4.17) as compared to CT of wheat with lower BCR (3.23) (Table 2, 3). While regarding perception about yield factor 46% farmers during survey said that ZT provided more yield than CT method.

**Table 3. Cost and Return Estimation of Wheat Production (Rs. $ha^{-1}$)**

| Particular | Conventional Tillage | Zero Tillage with Happy Seeder | Change (%) |
|---|---|---|---|
| Land preparation | 6545 | 0 | -100.00 |
| Sowing operation | 5935 | 6375 | 7.41 |
| Seed | 5808 | 5391 | -7.18 |
| Irrigation | 4067 | 3579 | -12.00 |
| Fertilizer | 15729 | 13894 | -11.67 |
| Plant protection | 3705 | 3705 | 0.00 |
| Harvesting/threshing | 5765 | 5765 | 0.00 |
| Total operational cost | 47554 | 38708 | -18.60 |
| Wheat sale price (Rs. $mound^{-1}$ ) | 1223 | 1223 | 0.00 |

| | | | |
|---|---|---|---|
| Value of bhoosa (Rs. mound$^{-1}$ ) | 425 | 425 | 0.00 |
| Total gross returns | 153503 | 161516 | 5.22 |
| Net benefits | 105949 | 122808 | 15.91 |
| Benefit-cost ratio | 3.23 | 4.17 | 29.10 |

The significant yield effects of ZT on wheat might be associated with timely sowing, improved input use efficiency and the better weed control (Mehla *et al.* 2000). The more wheat yield of 11% (400 kg ha$^{-1}$) was recorded with ZT than CT in the Indo-Gangetic Plains (Dhiman *et al.* 2003). Malik *et al.* (2005) conducted a field survey study through interviewing 398 farmers and estimated a significant yield increase (153 kg ha$^{-1}$) for ZT adopters. Erenstein *et al.* (2007) conducted a field survey study through interviewing 400 farmers and estimated a significant yield gain (170 kg ha$^{-1}$) for ZT adopters. According to Rehman *et al.* (2011) and Gill (2006) ZT resulted in more yield than CT due to timely sowing, less weeds incidence, better crop stand and fertilizer efficiency. The present study results are also in accordance with Sharma et al. (2008) and Kahloon *et al.* (2012) who concluded that resource conservation through ZT might help to reduce environmental problems, improvement in productivity of crop and to enhance the sustainability in rain fed agriculture.

**Farmers' Perception for Adoption of Happy Seeder**

As far as the farmers' perception for HS adoption is concerned; in present survey study, 90% farmers were of the view that HS is timely sowing method, 21% farmers said that proper seed is placed in HS, 62% farmers said that HS results in better fertilizer uptake by wheat crop as well as HS reduce soil erosion, 79% reported increased organic matter, 26% pointed out less weed establishment by adopting HS while 46% said that higher yield occurs due to HS as compared to CT. Also the 25% farmers had perceptions that HS saved irrigation charges, 74% considered ZT as labor and fuel saving, and 54% farmers viewed that ZT conserves soil moisture than CT.

The zero tilled soils reportedly have higher organic carbon contents and lower pH due to nitrification resulting in reduced soil erosion than conventional tilled soils (Malik *et al.* 2002). According to Franke *et al.* (2007) the upper soil surface in ZT system was relatively soft and contained more moisture content. Adam *et al.* (2018) reported that farmer's perception for adoption of HS as 5% described that HS improved the soil health, 17% reported higher profit, 33% perceived higher yield and 21% said that zero tillage with HS resulted in lower cost of production.

**Farmers' Perception for Non-Adoption of Happy Seeder**

In present survey, 21% farmers considered that there is need of high HP tractor for HS operation, 43% farmers viewed that HS is not available easily and its initial investment cost is higher, 34% said that machine transportation is laborious, 32% reported that combine harvested rice residue cause hurdle in sowing with HS, 54% raised the issue of poor crop stand in un-leveled land, 16% raised the need of gap filling, 14% farmers viewed that ZT is not suitable in heavy clay soils, 12% farmers highlighted the issue of soil compaction, only 6% farmers considered the more rust attack, more rice stem borer and improper field capacity at planting time are the constraints for ZT adoption.

According to Erenstein *et al.* (2007) there was a perception that after 3 to 4 years of ZT adoption the soil needed at least one plowing due to soil compaction risk. Malik *et al.* (1998) recorded more population of broad leaved weeds and a shift of weed spectrum in ZT wheat fields. Malik *et al.* (2002) estimated less intensity of *Phalaris minor* (30-40%) and more intensity of broad leaved weeds in ZT in comparison to CT. According to Jaipal et al. (2002) and Laxmi *et al.* (2003) ZT also changed the dynamics of diseases and pests and has no harmful effect on the population density of insect pests in general and the yellow stem borer of rice in particular. Malik *et al.* (2002) concluded that by adopting ZT in wheat crop the population of nematodes tended to declined. Iqbal *et al.* (2017) estimated higher yield in first year but declining trend of yield in subsequent years due to soil compaction. With the reason of prevailed loose rice straw the rodent population was estimated. Adam

*et al.* (2018) reported the farmer's perception for non-adoption of HS as 3% farmers had not credit/financial support, 5% expected lower yield by HS, 8% considered higher adoption cost of HS and 48% showed lack of information for HS.

## CONCLUSION

Due to wheat sowing with HS machine the significant yield gains (7.14%, mainly by timely sowing) as well as operational cost savings (18.6% due to tillage saving) was estimated. Farmers were of the view that use of HS is beneficial in improving the soil health, decreasing weeds, insects and diseases, improving wheat yield and economic benefits by decreasing the operational cost. Therefore HS is being recommended for better crop stand and grain yield in rice-wheat cropping system.

## REFERENCES

Adam L. Cummins J. Zuo A. Yargop R. (2018) Final report: value chain and policy interventions to accelerate adoption of zero tillage in rice-wheat farming systems across the Indo-Gangetic Plains. ACIAR, GPO Box 1571 Canberra ACT 2601, Australia.

Bhushan L. Ladha J.K. Gupta R.K. Singh S. Tirol A.P. Sarawat Y.S. Gathala Pathak M.H. (2007) Saving of water and labour in rice-wheat system with no tillage and direct seeding technologies. Agron. J. 99(5): 1288-1296.

Malik R.K. Balyan R.S. Yadav A. Pahwa S.K. (2002) Herbicide resistance management and zero tillage in rice-wheat cropping system. Hisar, India CCSHAU. pp. 5-171.

CIMMYT. (1988) From Agronomic Data to Farmers Recommendations: An Economics Training Manual. No. 27. CIMMYT Mexico.

Dhiman S.D. Kumar S. Om H. (2003) Shallow tillage and drill technology for wheat. Ind. Farm. 53(5): 10-13.

Erenstein O. Malik R.K. and Singh S. (2007) Adoption and Impacts of zero tillage in the irrigated rice-wheat systems of Haryana, India. Research Report. New Delhi, India, CIMMYT and RWC.

Farooq U. Sharif M. Erenstein O. (2007). Adoption and impacts of zero tillage in the rice-wheat zone of irrigated Punjab, Pakistan. Research Report. CIMMYT India & RWC, New Delhi, India.

Franke A.C. Singh S. McRoberts N. Nehra A.S. Godara S. Malik R.K. Marshall G. (2007) Phalarisminor seedbank studies: longevity, seedling emergence and seed production as affected by tillage regime. Weed Res. 47(1):73-83.

Gill M.A. (2006) Zero tillage wheat production in rice-wheat cropping system: evidence from farmer's field. Pak. J. Agric. Res. 19(4): 1-6.

GOP. (2019) Pakistan Economic Survey 2018-19. Economic Advisor's Wing, Finance Division, Islamabad, Pakistan. pp.18.

Hobbs P.R. Gupta R.K. (2003) Resource-conserving technologies for wheat in the rice-wheat system. In: Ladha J.K. Hill J.E. Duxbury J.M Gupta R.K. Buresh R.J. (eds.) Improving the productivity and sustainability of rice-wheat systems: issues and impacts. ASA Special Publication Number 65. Madison, Wisconsin, USA: ASA-CSSA-SSSA. pp. 149-172.

Iqbal M. Khan M.A. Anwar M.Z. (2002) Zero-tillage technology and farm profits: a case study of wheat growers in the rice zone of Punjab. The Pakistan Development Review 41: 4 Part II (Winter 2002) pp. 665-682.

Iqbal M.F. Hussain M. Faisal M.N. Iqbal J. Rehman A.U. Ahmad M. Padyar J.A. (2017) Happy seeder zero tillage equipment for sowing of wheat in standing rice stubbles. Int. J. Adv. Res. Biol. Sci. 4(4): 101-105.

Jaipal S. Singh S. Yadav A. Malik R.K. Hobbs P. (2002) Cropping habitat in semi-arid subtropical north-west India in relation to modified tillage practices of wheat sowing. Hisar, India: CCSHAU. pp. 166-171.

Kahloon M.H. Iqbal M.F. Farooq M. Ali L. Fiaz M. Ahmad I. (2012) A comparison of conservation technologies and traditional techniques for sowing of wheat. J. Anim. Pl. Sci. 22(3):827-830.

Latif M.T. Sher F. Bashir A. Asghar M. Faisal N. Hussain M. (2017) A field survey to identify the problems in adaptability of direct seeded rice. Azarian Journal of Agriculture. 4(4): 139-144.

Laxmi V. Erenstein O. Gupta R.K. (2007) Impact of zero tillage in India's rice-wheat systems. D.F. CIMMYT, Mexico.

Laxmi V. Gupta R.K. Swarnalatha A. Perwaz S. (2003) Environmental impact of improved technology - farm level survey and farmers' perception on zero tillage (case study). In: Proceedings roles of agriculture workshop. Indira Gandhi Institute of Development Research, Mumbai, India. pp. 20-22.

Malik R.K. Gill G. Hobbs P.R. (1998) Herbicide resistance - a major issue for sustaining wheat productivity in rice-wheat cropping systems in the Indo-Gangetic plains. Rice-Wheat Consortium Paper Series 3. New Delhi, India, RWC.

Malik R.K. Gupta R.K. Yadav A. Sardana P.K. Punia S.S. Malik R.S. Singh S. (2005) The socio-economic impact of zero-tillage in rice-wheat cropping system of Indo Gangetic plains. In: Malik R.K. Gupta R.K. Yadav A. Sardana P.K. Singh C.M. (eds.) Zero tillage - the voice of farmers. Technical bulletin No. 9. Hisar, India: Directorate of Extension Education, CCSHAU. pp. 5-28.

Mehla R.S. Verma J.K. Gupta R.K. Hobbs P.R. (2000) Stagnation in the productivity of wheat in the Indo-Gangetic plains: zero-till-seed-cum-fertilizer drill as an integrated solution. Rice-wheat consortium paper series 8. New Delhi, India: RWC.

Mishra J.S. Singh V.P. (2012) Tillage and weed control effects on productivity of a dry seeded rice-wheat system on a vertisol in central India. Soil Tillage Res. 123(1):11- 20.

Raju R. Thimmappa K. Tripathi R.S. (2012) Economics of zero tillage and conventional methods of rice and wheat production in Haryana. J. Soil Salin.Water Qual. 4(1): 34-38.

Rehman H.M. Ali S. Akram M.M. (2011) Resource conservation strategy for enhancing wheat productivity in Pakistan. Mycopath 9(2): 79-85.

Sharma R.K. Chhokar R.S. Chauhan D.S. Gathala M.K. Rani V. Kumar A. (2002) Paradigm tillage shift in ricewheat system for greater profitability. In: Malik R.K. Balyan R.S. Yadav A. Pahwa S.K. (eds.), Herbicide resistance management and zero tillage in rice-wheat cropping system. Hisar, India: CCSHAU. pp. 131-135.

Sharma R.K. Chhokar R.S. Singh R.K. Gill S.C. (2008) Zero tillage wheat and unpuddled rice: the energy, labour and cost efficient alternatives to conventional rice-wheat system. In: Proceedings of the 14th Australian Agronomy Conference (MJ Unkovich). Adelaide, South Australia. pp. 147-158.

Sidhu H.S. Singh M. Humphreys E. Singh Y. Singh B. Dhillon S.S. Blackwell J. Bector V. Singh M. and Singh S. (2007) The Happy Seeder enables direct drilling of wheat into rice stubbles. Aus. J. Exp. Agr. 47(7):844-854.

Singh Y. Sidhu H.S. Singh M. Dhaliwal H.S. Blackwell J. Singh R.P. Humphreys L. Singla N. Thind H.S. Lohan S.K. Sran D.S. (2009) Happy Seeder -a conservation agriculture technology for managing rice residues. Technical bulletin No.-2009/01, Department of Soils, Punjab Agricultural University, Ludhiana, India. pp. 10.

Tahir M.A. Sardar M.S. Quddus M.A. Ashfaq M. (2008) Economics of zero tillage technology of wheat in rice-wheat cropping system of Punjab, Pakistan journal of Anima. And Plant Science 18(1): 42-46.

Younas M. Rehman M.A. Hussain A. Ali L. Waqar M.Q. (2016) Economic comparison of direct seeded and transplanted rice: evidences from adaptive research area of Punjab Pakistan. Asian Journal of Agriculture Biology. 4(1): 1-7.