Onions in the farming systems of the Swat Valley, Northern Pakistan: Implications for research and extension

T. Defoer*, S. S. Hussain, Martien van Nieuwkoop and O. Erenstein

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Summary

Onion cultivation in Swat Valley, Northern Pakistan, is increasingly becoming important, replacing wheat in the Rabi (winter) season. The area increased from 1000 ha in 1986 to 3000 ha in 1991. Due to its relatively recent importance as a cash crop, information on: (1) management practices, (2) factors determining yields, and (3) the economics of onion cultivation, was hardly available. A diagnostic study organized in 1991 addresses these issues. Its results indicate that onion yields and the economics of onion cultivation are significantly affected by: (1) high seed rates in nurseries, (2) use of poorly drained basin type nurseries, (3) late transplanting, (4) high weed infestation in onion fields, and (5) early harvesting. Despite the 67% higher input costs, induced by seed rates 20 times higher as usually recommended, onion cultivation in Swat Valley is attractive. Net benefits amount to approximately Rs. 45000 (1800 US$) per ha or 2 times as high as the net benefits per ha of wheat cultivation.

Résumé

La culturede l'oignon dans la "Swat Valley" du nord Pakistan, devient importante et remplace le froment au cours de la saison d'hiver. La surface cultivée est passée de 1000 ha en 1986 à 3000 ha en 1991. A cause de son importance relativement récente comme culture de rente, il s'avérait nécessaire d'obtenir des informations sur: 1) les pratiques de gestion, 2) les facteurs influençant le rendement, 3) la rentabilité de la culture d'oignons.

Une étude diagnostique organisée en 1991 a fourni des réponses à ces questions. Les résultats montrent que les rendements en oignon et la rentabilité de la culture d'oignons sont influencés significativement par 1) les hautes doses de semis en pépinières, 2) l'installation des pépinières dans des bassins mal drainés, 3) la transplantation tardive, 4) la forte infestation des champs d'oignons par des mauvaises herbes et, 5) la récolte précoce. Malgré des intrants de 67% plus élevés, par suite de semis à des doses 20 fois supérieures aux valeurs habituellement recommandées, la culture des oignons dans la "Swat Valley" est séduisante. Les bénéfices nets avoisinnent 45000 Rs (1800 US$) par hectare, soit le double du bénéfice net par hectare pour la culture du froment.

Introduction

The Swat Valley is an important onion producing area in the North West Frontier Province (NWFP) of Pakistan and accounts for 64 percent of the onion production in the province. It is a major crop of the valley, grown in the Rabi (winter) season. Between 1986 and 1991 the area under onions increased from 1000 ha to 3000 ha, mainly at the expense of the area under wheat which decreased from 24000 ha to 21000 ha. Due to its relatively recent importance as a cash crop, information on the role of onions in the farming systems is hardly available.

Analysis of on-farm fertilizer trials conducted by the Agricultural Development Programme of the PATA project in Swat Valley (4), showed considerable differences in yields among farms. Since factors explaining these differences could not be determined from the available monitoring data, a diagnostic study was conducted with the following objectives:

- to obtain information about the importance of the onion crop in the farming systems of the Swat valley;
- to study the management practices followed in the cultivation of onions;
- to identify factors influencing onion yields;
- to determine the economics of onion cultivation;
- to identify problems and their underlying causes in onion cultivation; and
- to formulate interventions for research and extension.

Methodology

The onion producing area in Swat valley is covered by two extension circles: (1) Barikot, in the Southern part, and (2) Khawazakhela, in the Northern part. In both areas, an informal survey and a multiple visit formal survey were conducted during the Rabi 1989-90 season[1].

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[1] The Barikot extension circle and the Khawazakhela extension circle will be further in the text mentioned as Barikot and Khawazakhela, respectively This means that they represent the total production area and not the respective village names.

The informal survey was conducted by a multi-disciplinary team, consisting of an agronomist, an agro-economist and an irrigation specialist. A one day field visit was organised at two stages in the growing period: the first visit during the onion nursery stage and the second visit about two months after transplanting, in March. Field observations were made on crop development and the importance of weed infestation. Open discussions with farmers were held guided by a checklist of important issues to be covered.

For the multiple visit formal survey, a sample of 28 farmers (14 in each extension circle) was selected. Each farmer was visited and interviewed four times during the onion growing period. To study a possible relation between management practices and tenancy arrangement, in both extension circles the sample was stratified, including 50% tenant-cultivators and 50% owner-cultivators.

General characteristics of the farming systems

The Agro-ecological setting

The climate of the Swat valley is characterised by relatively short springs and autumns, hot summers and cold winters with a rare frost. Barikot is situated at an altitude of about 850 m.a.s.l., while Khawazakhela is located at about 1000 m.a.s.l. In Khawazakhela, winters are longer and colder than in Barikot. Since temperature plays an important role in the bulking process of onions (6), bulb formation will take place more quickly in Barikot than in Khawazakhela, after the minimum photoperiod (11 to 16 hours) has reached. Rainfall occurs throughout the year although two seasons can be distinguished: February-March and July-August. Seasonal fluctuations in rainfall and temperature are, however, considerable.

In respect of the origin of soils and their mode of deposition, two categories can be distinguished: (1) piedmont deposits which mainly consist of alluvial fans, desiccated by hill torrents and (2) flood deposits mainly along the riverbank, irrigated by the Swat river through "civil canals" Onions are generally grown on well drained soils along the riverbank. Physico-chemical characteristics of the flood deposit soils of Barikot and Khawazakhela are quite similar Shortage of water normally does not occur during the onion growing season, which lasts from December to June (1).

Socio-economic characteristics of the farmers

The average household size for the sample farmers is 11,5 and 15,9 for Barikot and Khawazakhela, respectively. Each family employs 3 to 4 members full time in agriculture. However, other family members also work part-time on the farms, especially during the peak seasons. The average cultivated area of the sample farmers is 1 ha, varying between 0,04 and 10,0 ha. Tenants tend to cultivate smaller farms (0,76 ha) than owners (1,32 ha). In Barikot, the average cultivated area is about 1,13 ha which is 41% higher than the average cultivated area in Khawazakhela.

Two types of tenancy arrangements exist in onion cultivation, namely on a share and on a lease basis. The share or *Brakha* system is based on 50% share of the inputs and produce and is found in only 13% of the cases. The lease or *Ijara* system is based on a fixed amount in cash, generally per season. The average rent amounts to Rs. 7360 per ha, varying from about Rs. 2100 to Rs. 12350 per ha. The rent largely depends upon the access to the road and land quality, which farmers mainly evaluate in terms of fertility, based on yields obtained from previous crops.

Onions in the farming systems

The main Rabi crops in the irrigated farming systems of the Swat valley are wheat, onions, peas and shaftal (*Trifolium resupinatum,* Persian Clover), while the main Kharif (summer) crops are rice, maize and vegetables. Double cropping is common in both areas. Orchards are commonly found, of a wide variety of fruits such as plum, apricot, apple and persimmon.

The average area of the onion sample fields is 0,34 ha which is about 35% of the average cultivated area of the sample farmers. Considerable differences in area under onions are found among the sample farmers. The total cultivated area under onions is about 50% in case of tenant-cultivators, but only 30% in case of owner-cultivators. The average farmer's area under onions in Barikot is more than the double of the average farmer's area in Khawazakhela.

Although rice-wheat still is the main cropping pattern in Swat valley, three different cropping patterns which include onions, can be distinguished. 66% of the farmers follow a rice-onions rotation, 26% a maize-onions rotation and the rest a vegetable-onions rotation. Hence the rice-wheat cropping pattern is gradually replaced by a rice-onions cropping pattern. In the rice-onions rotation, time conflicts between the harvesting of onions and the land preparation for rice planting often results in poor land preparation, as well as, late transplanting of rice. Poor land preparation increases weed infestation in rice and late transplanting reduces rice yields (5). In the maize-onions rotation, the period between the harvest of the onions and the sowing of maize is also quite short. However, the negative influence of late sowing of maize under irrigated conditions is less significant than for rice. On the other hand, sufficient time is available for onion transplanting in each cropping pattern. The optimal crop rotation could therefore be, onions-maize-wheat-rice. Half of the surveyed farmers cultivate onions each year on the same field. The other farmers replace onions with wheat (27%) or shaftal (23%) during Rabi, once every two years.

Management practices in onion cultivation

Management practices in onion nurseries

Most of the onion nurseries are established in maize or tomato fields. Rice fields can not be used for onion nurseries because late harvesting of rice (from mid-October onwards) does not allow their early establishment. Most of the farmers (72%) establish onion nurseries on the same piece of land every year The main reason for this is that farmers select a fertile piece of land of good quality for their nursery which is further upgraded through the regular application of farm yard manure (FYM). However, 24% of the survey farmers rotate the onion nursery with shaftal. Shaftal, being a leguminous crop, improves the fertility and quality of land.

Bullocks are the most common source of draught power used for ploughing of nursery fields (74%). 80% of the farmers prepare land for the onion nursery around the beginning of October. All farmers apply FYM to the nursery with an average of 74100 kg per ha, ranging from 17290 to 172900 kg. In addition, nearly all farmers apply mineral fertilisers during land preparation of the nursery. Nurseries are usually sown during the first half of October In Barikot sowing starts one week earlier than in Khawazakhela.

Nearly all farmers use the Red Glossy variety, which is a local landrace. The seed is usually produced by the farmers themselves. All farmers broadcast onion seed and then cover it with a layer of FYM of about 1 cm. Farmers do not treat the onion seed or the seedbed before sowing. Furthermore, no measures are used to protect the seedbed against drying out.

The average seed rate is 49 grams of seed per square meter of nursery, which is more than 20 times the international recommended seed rate (6, 10). Farmers in Khawazakhela use, on average, 54% more seed than farmers in Barikot. The average seed rate per ha of transplanted fields is 38,8 kg, which is about 9 times the commonly recommended seed rate (2, 8). The variation in seed rate among the sample fields is quite high (Figure 1). The field-nursery ratio is on average 18 and varies from 3 to 49, while the recommended ratio is only 5. The field-nursery ratio in Khawazakhela is about twice that of Barikot (figure 2). The main reason for the high field-nursery ratio and the high nursery seed rate could be the limited land availability at sowing time, due to the presence of the rice crop in the fields.

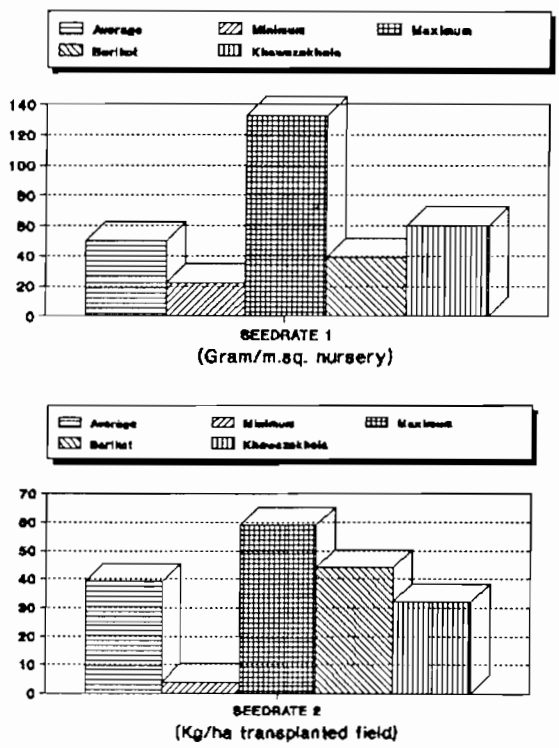

Figure 1 — Seed rate in nursery and in the transplanted fields and field-nursery ratio

Hand weeding in onion nurseries is common. Farmers consider hand weeding as a laborious but necessary job for producing healthy seedlings. Own labour is preferred, but some farmers (35%) also use hired labour for weeding. On average, 15 hours are required to weed 10 square meters of nursery. Labour use for nursery weeding is, however, higher in Khawazakhela (21 hours per square meter). This is most probably due to the higher seed rate and consequently the higher plant density in the nurseries in Khawazakhela compared to Barikot.

Because of high seed rates in nurseries, only 68 percent of the seed develops to seedlings. A negative correlation coefficient of 0,71 (significant at 0,1%) was calculated between the nursery seed rate and germination survival percentage. This confirms that high seed rates in nurseries result in poor germination and high seedling death.

Although symptoms of Damping-off disease are commonly found in onion nurseries, curative measures are rarely taken. Poorly drained soils and basin shaped nurseries, with high moisture retention due to standing water, must be seen as the main reason for Damping-off. The disease is especially observed in nurseries with a high plant density. High seed rates, causing a high plant density, resulting in low aeration, high ambient moisture and weak seedlings are other reasons for the high risk of Damping-off

A heterogeneous plant stand is another problem, which has been observed in 80% of the nurseries. Poor plant stand is seen at the water inlet of the basin, mainly because of flood irrigation which washes away the seed. Poor plant stand is also observed in the centre of the basins, probably due to standing water and resulting in high plant death in this part of the nursery. On the other hand, the borders of the basins have a better drainage and consequently a better plant stand A much poorer plant stand is observed in Khawazakhela compared to Barikot. Lower temperatures, late sowing and higher seed rates in Khawazakhela are the main reasons for this.

Management practices in onion fields

Land preparation

Land preparation in onion fields is usually performed by a hired tractor with a spring tine cultivator (Rs. 60 per hour). On average, 4,3 ploughings are done, ranging from 2 to 6.

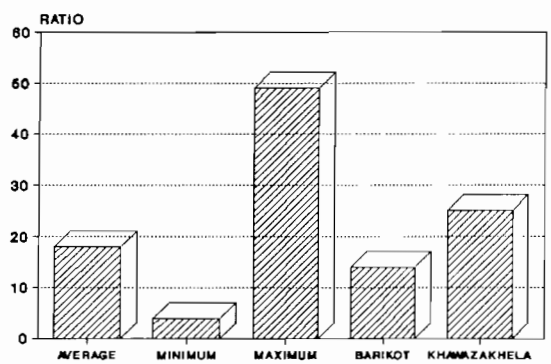

Figure 2 — Field nursery ratio

Land preparation for the onion fields is generally done in December. On average, land preparation in Barikot occurs 29 days earlier then in Khawazakhela, which is most probably due to the earlier availability of seedings in Barikot. The average period between land preparation and transplanting is 45 days varying from 7 to 85 days. Early land preparation is preferred, mainly to avoid winter rains starting from the middle of January, which makes ploughing of heavy soils difficult.

Transplanting

Transplanting of onion seedings is done from December 10 to March 8, whereas the recommendation is the last week of November. Transplanting in Barikot occurs 34 days earlier than in Khawazakhela, despite a difference of only one week in the average nursery sowing date between the two areas. Substantial variation is alos observed in the age of seedlings at the time of transplanting. The average age of the seedlings is 113 days, ranging from 54 days to 140 days. In Khawazakhela, the nursery stage takes 27 days longer than in Barikot. Lower temperatures due to late sowing and higher altitude, are the main reasons for the longer nursery period in Khawazakhela.

Before transplanting of onion seedlings in the field, a fine bed is prepared manually. Onion seedlings are transplanted in lines, in a furrow of about 5 cm deep. The seedling to seedling distance is about 7 cm, while the line to line distance is, on average 15 cm. The resulting average plant density is 94 plants per square meter, varying from 52 to 146. This figure is about 3 times higher than generally recommended (10). The preparation of the onion bed and the transplanting of onion seedlings are laborious activities and taking up more than 198 days per ha. Children are especially involved in this activity. 77% of the farmers also hired labour for transplanting (@ Rs. 30 per day).

Fertiliser application

The most common fertilisers used by farmers in onion fields are urea, ammonium sulphate, di-ammonium phosphate (DAP) and potassium sulphate.

Nitrogen is applied by all farmers. Although the recommended[1] rate is 153 kg nitrogen per ha, farmers apply on average 38% more (212 kg per ha). Only 50% of the sample farmers use phosphorus. They apply, on average, 30% more than the recommended dose of 114 kg P_2O_5 per ha. Potassium is only used by 14% of the farmers. They apply 69 kg of K_2O per ha on average, which is 56% of the recommended rate. Farm yard manure (FYM)[2] is used by less than half of the farmers. Those who use FYM, apply an average rate of 21242 kg per ha.

Owner-cultivators apply two times more TYM than tenants and use 25% more phosphorus. Tenants, on the other hand, apply more nitrogen to compensate for FYM and phosphorus. FYM and phosphorus have a residual effect and are only partly profitable to the onion crop. Their application can therefore be considered as a kind of investment. Tenants, who have a lease agreement of only one cropping season, probably do not prefer to invest in these expensive fertilisers as the long term benefits go to the landlord. They, nevertheless, compensate for this by using higher doses of nitrogen. This could have long term sustainability implications. The quality of land that is being rented out may degrade with an intensive but imbalanced use of fertilisers.

Farmers in Barikot use 57% more FYM and 150% more phosphorus than farmers in Khawazakhela, while farmers in Khawazakhela apply 43% more nitrogen. Khawazakhela being characterised by cold and prolonged winters, is less favourable for onion cultivation which might affect farmers' decision on investment in fertiliser use.

Cropping pattern and rotation practices also influence farmers' decision on fertiliser application. Substantially more nitrogen (74%), and more phosphorus (193%) are applied after rice than after maize, vegetables or fallow. Since maize or vegetables commonly receive higher doses of FYM and phosphorus than rice, farmers apply less FYM and phosphorus to onions following these crops.

The application of FYM, phosphorus and potassium is done just before transplanting. 39% of the farmers also apply nitrogen at that time. However, the common practice is a top dressing of nitrogen, as more than 80% of the amount of nitrogen is applied after transplanting. Farmers normally apply the top dressing of nitrogen quite late (around April) which is about 2 months after transplanting. In two cases, high doses of nitrogen were even applied less than 1 month before harvest (during the month of June). Although it is certainly not a favourable practice for bulb formation, farmers probably apply nitrogen at this stage to compensate for poor plant development.

Pest Control

Weeds are a major problem in onions. The most important weeds are *Cyperus rotundus* and *Phalaris minor. Avenu fatua* (wild oats) and *Cynodon dactylon* (Kabal grass) are also found in some fields. Apart from grasses, dicotyledons such as *Vicia sativa, Rumex dentatus* and *Chenopodium album* also commonly infest onion fields.

Weed infestation becomes serious from March onwards. Hand weeding is a common practice during April and May, using on average, 398 hours of labour per hectare. The high labour use for hand weeding is mainly due to the high plant density and hence, the need for careful weeding. Family labour for hand weeding is preferred. Nevertheless, 55% of the farmers also use hired labour for hand weeding.

In addition to hand weeding, herbicides (Tribunal = metabenzthiazuron) are also used by 72% of the respondents. Farmers using herbicides spend, on average, 34% less time in hand weeding than those who dit not (significant at 10%).

Insect and disease infestation remain quite low up to mid-April. From then on, Trips tabacci are observed in almost all onion fields. Downy mildew disease is also found in some onion fields, but is less severe. Its incidence is 40% higher

1 The fertiliser recommendations are blanket recommendations of the extension service, developed by the local research institute; they are based on fertiliser trials at the research station and are not location specific

2 Farm Yard Manure (FYM) is fresh FYM.

in Barikot than in Khawazakhela. The high concentration of onion fields combined with the general higher temperatures in Barikot, migth be favourable conditions for Downy mildew outbreak.

Chemical control of insects and diseases is less common than chemical control of weeds. Nevertheless, 48% of the farmers use at least one type of insecticide or fungicide. Although insects (such as *Trips tabacci)* are a major problem in onion fields, insecticides (like Dimecron = Fosphamidon) are used by only 15% of the farmers. Apparently, farmers are not able to make a linkage between an insect or disease problem and an efficient method of control. 68% of the sample farmers even did not recognize insect or disease symptoms in onions.

Harvesting

Farmers, on average, harvest onions on June 26. The average period between sowing/transplanting and harvesting is 259/147 days. The period between transplanting and harvesting in Barikot is 31 days longer than in Khawazakhela (statistically significant at 1% level). This means that onions in Khawazakhela are less mature at harvesting than in Barikot.

Onions are normally harvested too early. A major reason is the need to free land for rice transplanting. Farmers practice of late irrigation up till two to three days before harvesting, however, does not induce maturity. Harvesting of onions is done by hand. Leaves, which are normally still green, are cut with a knife at about 1 cm above the bulb neck. Little time is normally left for the curing of onions after harvesting.

Yield of onions

The average yield of the sample fields is 29146 kg/ha. This is more than twice the world average, but is still 16% lower than the average onion yield in the USA (6). The average yield obtained in Barikot is 10014 kg/ha, which is two times higher than the average in Khawazakhela, and 125% above the average yield in the USA.

In order to gain a better understanding of the factors influencing the onion yield, a regression analysis was made with the onion yield as the dependent variable. The best fitting regression equation is obtained by including the following independent variables:

1 weed infestation in onion fields: scores

- 1 = no weed infestation
- 3 = little weed infestation (< 10% groundcover)
- 5 = medium weed infestation (< 50% > 10% groundcover)
- 7 = high weed infestation (> 50% groundcover);

2. plant density in nursery (plants/m^2);

3. period between transplanting and harvesting (in days)

The equation explains 58% of the variance. The regression shows that the plant density in the nursery and weed infestation in the field, are the major factors negatively influencing the yield of onions. High plant density in the nursery is a consequence of the high seed rate and results into weak seedlings, vulnerable to diseases. After transplanting, the weak seedlings take a long time before they start growing and plant death frequently occurs. A correlation coefficient of 0,54 (significant at 1% level) could, indeed, be calculated between plant density in the nursery and plant death after transplanting. A consequence of high plant death is a reduced plant density at harvesting time, negatively influencing yields.

Table 1:

Regression results of factors affecting onions yield in Swat valley

Variable	Coefficient	T-value
Constant (kg/ha)	25380	
Weed infestation (score)	-1835	4,51**
Plant density in nursery (plant/m2)	-0,9	2,80**
Days between transplanting and harvest	115	2,28*

*,**: Statistical significant at 5% and 1% level respectively
R2 = 0,58; degrees of freedom = 19

Since weeds are competing with onions, weed infestation seriously decreases yields. Moreover, high weed infestation may also cause plant death and thus further decrease the plant density at harvesting time. This is reflected by the positive correlation coefficient of 0,33 (significant at the 5% level) between weed infestation and plant death.

The time between transplanting and harvesting has a significant positive influence on the onion yield. The regression results show that each extra day between transplanting and harvesting increases the yield of onions by 115 kg per ha. Early transplanting will allow the plants sufficient time to produce more leaves and thus better vegetative growth, before the start of longer days and a rise in temperature which cause the unset of bulking. Transplanting later than the beginning of December is also risky because winter rains can make it impossible to transplant onion seedlings at the expected date. Onion yields could also be increased by later harvesting. Farmers, however, are constrained by the need to clear the onion field for the next crop while early harvested onions generally fetch a higher market price. Consequently, harvesting is often too early. Hence, the period between transplanting and harvesting can mainly be increased by earlier transplanting. Since the land is normally free long before transplanting time, earlier transplanting is likely achievable.

The average yield in Barikot which is two times higher than in Khawazakhela, can be partly explained by the differences in the above mentioned factors affecting yields. Comparing Khawazakhela to Barikot, the plant density in the nursery is 54% higher, the weed infestation i the field is higher by a factor 3,2 and the period between transplanting and harvesting is 31 days shorter. The shorter winter in Barikot compared to Khawazakhela positively influencing the start of the bulb formation, resulting in a longer bulking period, is most probably another important reason for the higher yields in Barikot compared to Khawazakhela. Results of physico-chemical soil analysis, on the other hand, did not explain differences in yields.

Economics of onion cultivation

Table 2 shows the crop budget of onions calculated by using the sample average input and output data. As shown in the previous sections, onion cultivation requires an intensive use of physical inputs (notably seed, fertiliser and chemicals). The total physical input cost in onion cultivation is Rs. 25611 per ha.

Most input costs (80%) are incurred during the nursery stage. This is mainly due to the extremely high seed rates in connection with the high price of onion seed. The cost of seed amounts to 75% of the total physical input costs. Farmers can save, on average, Rs. 17166 (or 67% of the total physical input costs), if they use the recommended seed rates of 3,2 kg per ha of transplanted field.

Besides physical inputs, onion cultivation also requires an intensive use of labour The total labour cost in onion cultivation is Rs. 15442/ha, of which, 12% is incurred during the nursery stage. The high labour cost is mainly related to the practices of transplanting, weeding and harvesting, which are done manually.

TABLE 2:
Crop budget for onion cultivation (per ha)

	Quantity	Price (Rs./unit)	Value (Rs.)
A. Physical inputs			
Onion nursery			
1. Seed (kg)	38,78	500,0	19390
2 FYM (tonnes)	7,8	125,0	985
3 Urea (kg)	71,14	3,0	213
4. DAP (kg)	25,44	4,4	112
Sub-total nursery			20700
Onion field			
5 Land preparation (hrs)	10,62	60,0	637
6 FYM (tonnes)	8,90	125,0	1111
7. Urea (kg)	397,67	3,0	1193
8. DAP (kg)	112,14	4,4	493
9. Ammonium sulphate (kg)	353,21	1,5	530
10. Potassium sulphate (kg)	13,09	2,2	29
11 Tribunal (kg)	2,59	300,0	777
12. Dimecron (litre)	0,49	280,0	137
Sub-total field			4907
TOTAL INPUTS COST			25607
B. Labour (hours)			
Onion nursery			
13 Land preparation	39,52	4,0	158
14 Bed Preparation + sowing	59,28	4,0	237
15. Weeding	377,91	4,0	1512
Sub-total nursery			1907
Onion field			
16. Land preparation	88,92	4,0	356
17 Transplanting	1482,00	4,0	5928
18 Weeding	983,06	4,0	3932
19 Harvesting	829,92	4,0	3320
Sub-total field			13536
TOTAL LABOUR COST			15443
TOTAL COST (A + B)			41050
C. Output/Gross benefits	29146	3,0	87438
D. Gross margin (C-A)			61831
E. Net benefits (C-A-B)			46388

Note: 25 Pakistani Rupees (Rs) = 1 US$

The total cost of onion cultivation (physical input + labour input) is Rs. 41054/ha. The gross benefit amounts to Rs. 87438/ha. The net benefit is therefore Rs. 46384/ha. In these calculations land rent has, however, not been included. If a land rent of Rs. 7410/ha (a standard land rent observed for onion cultivation in Swat) is included, the net benefit comes down to Rs. 38974/ha. This still seems to be an attractive return, relative to other crops in the Swat valley.

Marketing of onions

Generally, farmers keep some of their produce for home consumption and for seed production for the next season. The major part of the onion produce is, however, sold. Onions are packed in bags of 90 to 100 kg, one to two days after the harvest for immediate marketing. The farmers sell their onions either through: (1) village traders (41%), (2) by taking the produce directly to the market individually (37%), (3) through collective marketing (11%), or through sale of the standing onion crop to traders (22%).

TABLE 3:
Onion prices under different marketing arrangements in Swat (1989-1990)

Type of arrangement	Price (Rs./kg)
Individual or collective marketing	3,43
Sale through traders	3,13
Sale of a standing crop	3,40
Average	3,32

The prices of onions received by farmers under the different marketing arrangements are rather similar (Table 3). Even if a farmer sells the standing onion crop, he receives, on average, a price of Rs. 3,40 per kg, which is only slightly below the average price of Rs. 3,43 per kg, by selling onions directly after harvesting. This indicates that farmers and traders are efficient in estimating the yield of the standing crop. A correlation coefficient of 0,86, statistically significant at 5%, is computed between the value received by farmers per hectare for a standing onion crop and the onion yields. This means that the sale of the standing crop is the most profitable marketing arrangement for farmers, since they do not have to make extra costs for harvesting, handling and transport in that case.

The price of onions is often at its lowest in the period directly after harvesting (June-July). The profits of onion cultivation may therefore be increased by on-farm storage of onions. However, the economics of onion storage at the farmer level are at present not clear. A number of factors determining the economics of storage are: (1) storage costs, (2) losses due to reduced weight and rotting, and (3) increased labour requirements. Furthermore, storage involves price risk because the increase of onion price mainly depends upon the supply of onions from Baluchistan (South Western Province) in August-September. For this reason a marketing information system may be needed to enable farmers to make a more rational decision concerning storage of onions.

Recommendations

Based on the findings, several recommendations can be made in order to make onion cultivation more profitable. Some of the recommendations can be directly used by the extension service, while others need further investigation by research.

Recommendations for research

The time conflict between harvesting of onions and planting of rice in the onions-rice cropping system has important implications for on-farm research. Alternative crash crops which have similar management practices as onions but which have the advantage of early harvesting and thus allowing sufficient time for rice land preparation, should be explored. Leek could be an option. At the same time intensive work on the selection of the Red glossy land race is recommended in order to develop an early maturing variety of onions.

Improved nursery techniques including low seed rate, line sowing ánd raised seed bed should be investigated in more detail. These practices should be evaluated in terms of Damping-off disease resistance, plant development and yield.

Given the negative influence of weed infestation on onion yields, a further study is needed to evaluate the pattern and importance of different weed species and to analyse the influence of farmers' management practices on the weed population and weed pattern. This study should emphasis recommendations on integrated weed control measures. In addition, on-farm trials are suggested to investigate the effect of a larger line to line distance combined with weeding with a "Dutch hoe" for effective weed control in onion fields.

On-farm experimentation is recommended to investigate the effect of improved harvesting and storage practices.

Recommendations for extension

Extension should emphasise training of farmers in recognising insect and disease symptoms in onions, by linking symptoms with the causing agents and their effective ways of control.

Extension should stress that onion nurseries should be laid out before the end of September, in order to allow transplanting of onion seedlings during the last week of November or the beginning of December

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The authors are respectively Agronomist and Agricultural Economist in the Pak-Holland PATA Project in the Northern Pakistan, P.O. Box 14, Saidu Sharif Pakistan. Agricultural Economist in the Economics programme of CIMMYT and Agricultural Economist in the Pak-Holland PATA Project.