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# Contingent crop planning for rainy and winter seasons in rainfed mid-hill conditions of Himachal Pradesh

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ABSTRACT

A field experiment conducted on contingent crop planning for rainy (*kharif*) and winter (*rabi*) seasons in mid-hill sub-humid zone of Himachal Pradesh revealed that if the major *kharif* maize (*Zea mays* L.) could not be sown or failed due to adverse climatic conditions, the sowing of blackgram (*Phaseolus mungo* L.) or horsegram [*Macrotyloma uniflorum* (Lamb.) Verdic.] in the first fortnight of August proved profitable, whereas maize, Frenchbean or *rajmash* (*Phaseolus vulgaris* L.), sunflower (*Helianthus annuus* L.), sesame (*Sesamum indicum* L.) and soybean [*Glycine max* (L.) Merr.] gave negative returns. All these crops fitted well in sequence with wheat (*Triticum aestivum* L. emend. Fiori & Paol.), however, blackgram–wheat sequence was found most remunerative. In another trial oat (*Avena sativa* L.) + sarson sown for green fodder from second fortnight of August to September gave significantly higher net returns than *toria* [*Brassica campestris* ssp *oleifera* (Metzger) Sinsk. var *toria*]–wheat, *toria*–barley (*Hordeum vulgare* L. sensu lato), *toria*–mustard [*Brassica juncea* (L.) Czernj. & Cosson] and *toria*-linseed (*Linum usitatissimum* L.) because *toria* crop gave negative returns. However, the net returns obtained only from wheat, barley and Indian mustard grown after catch crop of *toria* were at par with oat + *sarson* and rapeseed (*B. napus* L.) crop sown in October.

Extreme variability in amount and distribution of rainfall is one of the major constraints in improving production in Himachal Pradesh, where only 17% area is irrigated. Occurrence of rainfall early or late in season coupled with long-dry spells and or floods make it impossible to sow or grow main crops in time. Therefore optimum use of resources like limited land and available precipitation is of paramount importance, if crop productivity is to be raised substantially. Hence there is need for alternate crop planning with suitable and economically viable crops. However, no information is available on contingent crop planning for rainy (*kharif*) and winter (*rabi*) seasons. The present investigation was therefore carried out to find out most remunerative crops for sustained crop production under aberrant weather conditions.

## MATERIALS AND METHODS

The trials on contingent crop planning were conducted under rainfed valley conditions of mid-hill sub-humid zone of Himachal Pradesh during rainy (*kharif* ) and winter (*rabi*) seasons of 1989–90 and 1990–91. In Trial I, *kharif* crops were sown in the first fortnight of August and were followed by wheat (*Triticum aestivum* L. emend. Fiori & Paol.) in a permanent layout. The treatments consisted of maize (*Zea mays* L.), blackgram (*Phaseolus mungo* L.), horsegram [*Macrotyloma uniflorum* (Lam.) Verdic.], soybean [*Glycine max* (L.) Merr.],

**Table 1.** Weather parameters during crop periods of 1989–90 and 1990–91

| Crop period | Temperature (°C) | | Relative humidity (%) | | Rainfall (mm) | Rainy days | Evaporation (mm) |
|---|---|---|---|---|---|---|---|
| | Maximum | Minimum | Maximum | Minimum | | | |
| *1989–90* | | | | | | | |
| August | 30.0 | 19.7 | 92 | 57 | 134.0 | 12 | 129.0 |
| September | 30.2 | 16.2 | 91 | 47 | 21.0 | 3 | 144.5 |
| October | 28.1 | 8.0 | 92 | 29 | 7.5 | 3 | 109.5 |
| November | 21.5 | 3.5 | 93 | 32 | 51.9 | 7 | 48.0 |
| December | 16.5 | 2.3 | 91 | 41 | 48.2 | 7 | 28.4 |
| January | 17.5 | 2.3 | 91 | 40 | 28.8 | 3 | 31.5 |
| February | 14.9 | 3.5 | 90 | 54 | 168.0 | 13 | 45.6 |
| March | 18.3 | 5.6 | 90 | 49 | 266.5 | 15 | 101.5 |
| April | 25.0 | 7.4 | 88 | 32 | 52.6 | 7 | 111.3 |
| May | 30.4 | 14.1 | 85 | 36 | 58.5 | 8 | 149.5 |
| *1990–91* | | | | | | | |
| August | 31.0 | 20.8 | 91 | 57 | 141.1 | 14 | 129.9 |
| September | 29.6 | 18.1 | 91 | 54 | 15.8 | 9 | 107.7 |
| October | 26.7 | 8.0 | 90 | 30 | 17.9 | 6 | 103.8 |
| November | 20.6 | 2.7 | 92 | 24 | 3.0 | 2 | 65.5 |
| December | 17.6 | 0.3 | 91 | 35 | 111.3 | 7 | 34.1 |
| January | 14.9 | 0.4 | 90 | 37 | 18.1 | 6 | 32.1 |
| February | 16.3 | 3.3 | 87 | 43 | 156.0 | 11 | 52.1 |
| March | 20.5 | 6.1 | 92 | 40 | 127.0 | 12 | 85.6 |
| April | 24.3 | 7.3 | 92 | 40 | 139.8 | 13 | 110.7 |
| May | 29.8 | 10.7 | 84 | 36 | 75.8 | 14 | 147.3 |

Frenchbean or *rajmash* (*Phaseolus vulgaris* L.), sesame (*Sesamum indicum* L.) and sunflower (*Helianthus annuus* L.). In Trial II, 14 treatments comprising a catch crop of *toria* [*Brassica campestris* L. ssp. *oleifera* (Metzger) Sinsk. var. toria] was sown in the third week of August, followed by wheat, barley (*Hordeum vulgare* L. sensu lato), linseed (*Linum usitatissimum* L.) and Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson], *toria* sown in first week of October followed by sunflower, oat (*Avena sativa* L.) + sarson (*Brassica* sp.) sown in third week of August, first and third weeks of September for fodder; rapeseed (*Brassica napus* L.), Indian mustard, linseed and barley sown in mid-October; and wheat sown in mid-October and December. Each treatment in both the trials was replicated 3 times in randomized block design. The crops were raised with recommended package of practices. The total monetary returns and operating costs were calculated on the basis of prevailing market prices for working out net returns.

## RESULTS AND DISCUSSION

### *Rainy-season crops*

In Trial I all *kharif* crops gave higher yield in 1989 than in 1990 (Table 2). This was due to early establishment of crops and fairly well-distributed rainfall during 1989 (Table 1). In 1989 the total rainfall during August–September was 155 mm with 15

**Table 2.** Yield and net returns from various crop sequences

| Crop sequence | Rainy-season yield (q/ha)* | | | | | | Winter-season yield (q/ha) | | | | | | Net returns (Rs/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | | | Straw** | | | Grain | | | Straw | | | | | |
| | 1989 | 1990 | Mean | 1989 | 1990 | Mean | 1989–90 | 1990–91 | Mean | 1989–90 | 1990–91 | Mean | Rainy season | Winter season | Total |
| Maize–wheat | | | | 104.0 | 77.1 | 91.0 | 32.2 | 27.4 | 29.8 | 50.9 | 47.0 | 49.0 | –992 | 6,592 | 5,600 |
| Blackgram–wheat | 8.6 | 4.0 | 6.3 | 10.8 | 8.3 | 9.6 | 29.8 | 28.4 | 29.1 | 48.2 | 45.0 | 46.6 | 3,299 | 6,244 | 9,543 |
| Horsegram–wheat | 8.2 | 4,5 | 6.4 | 11.7 | 12.6 | 12.2 | 33.2 | 29.8 | 31.5 | 53.1 | 46.5 | 49.8 | 2,291 | 7,095 | 9,386 |
| Frenchbean–wheat | 2.9 | 0.8 | 1.9 | 5.1 | 1.8 | 3.5 | 35.5 | 26.1 | 30.8 | 50.0 | 44.8 | 47.4 | –1,473 | 6,740 | 5,267 |
| Soybean–wheat | 8.8 | 0.9 | 4.9 | 10.5 | 3.7 | 7.1 | 14.5 | 26.8 | 20.7 | 30.9 | 46,2 | 38.6 | –930 | 3,490 | 2,560 |
| Sesame–wheat | 0.4 | 0.4 | 0.4 | 5.9 | 6.2 | 6.1 | 14.2 | 24.7 | 19.5 | 31.8 | 45.3 | 38.6 | –2,490 | 3,176 | 686 |
| Sunflower–wheat | 4.6 | 5.9 | 5.3 | 8.2 | 9.0 | 8.6 | 13.7 | 25.5 | 19.6 | 23.4 | 46.0 | 34.7 | –213 | 2,942 | 2,729 |
| CD (P = 0.05) | | | | | | | | | | | | | 469 | 929 | 977 |

* Rainy-season crops sown in the first fortnight of August; ** In maize only green fodder was obtained

'Early Composite', 'T 9', 'Baizu', 'Jwala', 'Shivalik, 'Til No. 1', 'EC 68414' and 'CPAN 1796', 'HD 2380'/'Sonalika' were the varieties used for maize, blackgram, horsegram, Frenchbean, soybean, sesame, sunflower and wheat respectively

rainy days as against 156.9 mm with 23 rainy days in 1990. Early withdrawal of rains and high evaporative demand of atmosphere proved detrimental to maize which failed to complete its reproductive phase and thus produced only green fodder in both the years. Bali *et al.* (1991) made similar observations when sowing of maize was delayed.

*Winter-season crop*

In Trial I the wheat crop taken in sequence with various *kharif* crops showed variation (13.7–35.5 q/ha) in yield. There was very low yield of wheat in sequence with soybean, sesame and sunflower due to late maturity of these crops which delayed the sowing of wheat. Thus, December sowing of wheat coincided with erratic distribution of rainfall and low temperature in December–January, which resulted in delayed emergence of seedlings and great reduction in growing period. However, higher rainfall and comparatively higher temperature in November enhanced the germination and early establishment process in wheat in 1989–90. Lesser variation in yield (24.7–29.8 q/ha) in 1990–91 was due to almost dry weather in November and thus November- and December-sown wheat germinated together. Further, wheat crop was benefitted from well-distributed rains at the time of grain development in April during 1990–91 season (Table 1).

Like wheat in Trial I, the performance of *rabi* crops in Trial II was also better in 1989–90 than in 1990–91. A catch crop of *toria* sown in August gave very low yields. The sowing of wheat and barley at normal time (November) recorded higher yield than early (October) and late (December0 sowings. Similar results were obtained by Sharma and Chakor (1989). However, in rapeseed and Indian mustard the yield level during 1989–90 was almost same in October- and November-planted crops. This might be due to better utilization of residual soil moisture by these crops, as also reported by Sharma (1994). The low yield in October-planted oilseed crops during 1990–91 was due to near absence of rains for about 2 months. Sufficient and well-distributed rainfall in August resulted in extremely well performance of oat + sarson fodder during 1989–90 (Table 3).

*Net returns*

Among the various *kharif* crops, blackgram proved most profitable (Rs 3, 299/ha) and gave significantly higher net returns than other crops. Growing of maize, *rajmash*, soybean, sesame and sunflower gave negative returns, which showed these crops should not be grown if *kharif* sowing is delayed up to mid-August (Table 2). Though the crop of wheat taken after horsegram gave highest net returns (Rs 7,095/ha), there was no significant difference in the net returns obtained from wheat taken after either *rajmash*, maize or blackgram.

From the net returns realized in various crop sequences, it was revealed that blackgram–wheat (Rs 9,543/ha) and horsegram–wheat (Rs 9,386/ha) were most profitable sequences and gave significantly higher net returns over other sequences. *Toria* as catch crop proved highly non-profitable. Oat + sarson fodder gave significantly higher net returns than the total net returns obtained from *toria*–Indian mustard, *toria*–wheat, *toria*–barley, *toria*–linseed and *toria*–sunflower sequences (Table 3). However, when the losses incurred due to *toria* in sequences were not taken into consideration, Indian mustard, wheat and barley sown in November and rapeseed sown in October proved as

**Table 3.** Yield and net returns from catch crop of *toria* and winter-season (*rabi*) crops

| Treatment | Grain (q/ha) | | | | | | Straw (q/ha) | | | | | | Mean net returns (Rs/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989–90 | | 1990–91 | | Mean | | 1989–90 | | 1990–91 | | Mean | | | |
| | Catch crop | *Rabi* crop | Catch crop | *Rabi* crop | Catch crop | *Rabi* crop | Catch crop | *Rabi* crop | Catch crop | *Rabi* crop | Catch crop | *Rabi* crop | With catch crop | Only *rabi* crop |
| *Toria* (Aug. III week)–wheat (mid-Nov.) | 0.8 | 32.9 | 1.0 | 23.0 | 0.9 | 28.0 | 5.0 | 59.0 | 4.0 | 45.5 | 4.5 | 52.3 | 4,490 | 6,357 |
| *Toria* (Aug. III week)–barley (mid-Nov.) | 0.8 | 35.6 | 0.8 | 25.5 | 0.8 | 30.6 | 5.2 | 58.0 | 3.0 | 48.7 | 4.1 | 53.4 | 4,800 | 6,748 |
| *Toria* (Aug. III week)–linseed (mid-Nov.) | 1.1 | 12.3 | 1.2 | 8.0 | 1.2 | 10.2 | 4.6 | 20.1 | 3.5 | 12.4 | 4.1 | 16.3 | 2,218 | 3,866 |
| *Toria* (Aug. III week)–Indian mustard (mid-Nov.) | 0.6 | 16.8 | 1.2 | 9.6 | 0.9 | 13.2 | 3.9 | 29.3 | 3.8 | 20.7 | 3.9 | 25.0 | 5,089 | 6,965 |
| Oat + sarson (Aug. III week) green fodder | | | | | | | | 466 | | 182 | | 324 | | 7,215 |
| Oat + sarson (Sep. I week) green fodder | | | | | | | | 417 | | 216 | | 316 | | 6,946 |
| Oat + sarson (Sep. III week) green fodder | | | | | | | | 414 | | 250 | | 332 | | 7,485 |
| *Toria* (Oct. I week)–sunflower (Apr. I week) | 3.9 | [illegible] | [illegible]5 | 7.0 | 3.2 | 7.2 | 12.5 | 10.5 | 6.2 | 20.0 | 9.4 | 15.3 | 836 | 932 |
| Rapeseed (mid-Oct.) | | 16.7 | | 6.8 | | 11.8 | | 32.4 | | 18.3 | | 25.4 | | 5,921 |
| Indian mustard (mid-Oct.) | | 15.6 | | 6.0 | | 10.8 | | 33.9 | | 15.8 | | 24.9 | | 5,163 |
| Linseed (mid-Oct.) | | 10.8 | | 2.7 | | 6.8 | | 17.9 | | 5.0 | | 11.5 | | 1,624 |
| Barley (mid-Oct.) | | 28.4 | | 20.7 | | 24.6 | | 48.6 | | 42.3 | | 45.5 | | 4,917 |
| Wheat (mid-Oct.) | | 25.6 | | 19.3 | | 22.5 | | 47.8 | | 34.0 | | 40.9 | | 4,137 |
| Wheat (mid-Dec.) | | 17.0 | | 25.4 | | 21.2 | | 27.2 | | 47.0 | | 37.1 | | 3,541 |
| CD (P = 0.05) | | | | | | | | | | | | | 1,475 | 1,570 |

Crop varieties: *Toria* ('DK 1'), oat ('Palampur 1'), sarson ('BSH 1'), wheat (Early, 'VL 616' or normal, 'HD 2380' or late 'Sonalika'), barley ('Sonu'), linseed ('Janaki'), rapeseed ('Sheetal'), Indian mustard ('Varuna'), sunflower ('EC 68414')

profitable as oat + sarson fodder.

Thus, in rainfed valley areas of mid-hill sub-humid zone of Himachal Pradesh, blackgram and horsegram may be sown by the first fortnight of August when it was not possible to grow major *kharif* crop of maize or normal-sown *kharif* crops fail due to drought or heavy rains. If no *kharif* crops could be taken, oat + sarson for fodder should be sown (third week of August to September) or rapeseed, Indian mustard, wheat and barley should be taken, depending on the availability of soil moisture.

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