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RESEARCH NOTES

CONSTRAINTS TO DRYLAND DOUBLE CROPPING IN NORTHERN MADHYA PRADESH

Areas in India with deep, black (vertisol) soils, with rainfall greater than 750 mm. per year and with traditional *kharif* fallow have a major potential for increased total crop production. Two crops per year, without irrigation, are feasible in many years, depending on the rainfall pattern, with a *kharif* crop followed by traditional *rabi* crops. The development of double cropping of dryland is an opportunity to substantially increase both total production and farm incomes by use of existing, under-utilised production resources such as *kharif* land, water, sunshine and labour on an estimated 5 to 12 million hectares (ICRISAT, 1981; Jodha, 1986, Ryan *et al.*, 1982). For purposes of this paper, double cropping includes both sequential crops such as *kharif* (rainy season) soybeans followed by *rabi* (post-rainy season) wheat or chickpeas and intercrops such as soybeans and pigeon peas using both seasons to mature.

This paper examines constraints to large-scale double cropping (more than 50 per cent of dryland) which were identified in the village of Begumjung, Madhya Pradesh, about 120 kilometres east of Bhopal on the road to Sagar. The Madhya Pradesh Department of Agriculture and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) ran field trials of a package of technology designed to facilitate double cropping for three crop years, 1982-83 to 1984-85, in this village. Information reported here is based on a survey of field trial farmers and a few of their neighbours taken in February 1987, two crop years beyond the end of the field trials.

The three-year field trial experience shows that dryland double cropping can increase both total production and farm income (Table I). Double cropped plots produced three times the value of product compared to the single cropped plots. Although the operating costs for double cropping are substantially higher, the average gross profit from double cropping is more than three times greater. The reader is cautioned that this comparison does not separate various crops and cropping systems nor the variable use of technology, but it does indicate the relative potential of double cropping. Table II shows the distribution of gross profits among two double crop and two single crop systems. The beneficial cash flow characteristics of double cropping with crop income in both September and March were also mentioned by the farmers.

The use of the double cropping technology package developed by ICRISAT before, during and after the field trials is indicated in Table III. The farmers were clearly stimulated to adopt major components of the package by the field trials and have continued to use them. In particular, the interest in double cropping remains high. Other components were tried but had a low level of use two years after the end of the field trials.

In spite of Pandey's (1986) conclusion that in only eight years out of 29 were moisture conditions adequate for *rabi* crops following a *kharif* crop, several factors

TABLE I. AVERAGE PRODUCT VALUE, OPERATING COSTS, AND GROSS PROFITS ON SINGLE AND DOUBLE CROPPED LAND,[a] THREE YEARS OF FIELD TRIALS IN BEGUMGUNJ, MADHYA PRADESH, 1982-83 TO 1984-85

Particulars	Single crop plots	Dryland double crop plots
Number of plots	91	82
Total hectares	116.4	102.9
Average value per ha[b]		
(i) Gross value of product (Rs.)	1,279	3,966
(ii) Operational costs (Rs.)	623	1,708
(iii) Gross profits (Rs.)	656	2,258

Source: Adapted from Appendix Tables in Sangle and Sharma (1985).
a = Includes a variety of crops and crop combinations.
b = Average weighted by hectares.

TABLE II. FREQUENCY DISTRIBUTION OF GROSS PROFITS FROM DIFFERENT TYPES OF CROPPING SYSTEMS, THREE YEARS OF FIELD TRIALS IN BEGUMGUNJ, MADHYA PRADESH, 1982-85

	Type of cropping system			
Gross profits[a] (Rs./ha)	Soybean/ pigeon pea intercrop	Sequential cropping[b]	*Kharif* sole crop, *rabi* fallow	*Kharif* fallow, *rabi* crop
	(Number of plots)			
Below −1,000	0	4	3	1
−1,000 to 0	0	0	0	0
1 to 1,000	3	5	13	50
1,001 to 2,000	15	1	8	11
2,001 to 3,000	24	5	4	1
3,001 to 4,000	18	2	0	0
More than 4,000	5	0	0	0
No. of observations	65	17	28	63

Source: Foster *et al.*, (1987, p.18).
a = Gross value of product, including fodder, minus operational costs.
b = *Kharif* soybeans followed by any of several *rabi* crops.

TABLE III. USE OF COMPONENTS OF THE ICRISAT DOUBLE CROPPING TECHNOLOGY PACKAGE IN BEGUMGUNJ, MADHYA PRADESH BY 18 WATERSHED AND 7 NON-WATERSHED FARMERS BEFORE, DURING AND AFTER THREE-YEAR FIELD TRIALS (1982-83 TO 1984-85)

Practice	18 Watershed farmers			7 Non-watershed farmers
	Number using before 1982[a]	Number adopting during field trials	Number using in 1986-87	Number using in 1986-87
Kharif soybeans on dryland	4[b]	14[b]	13[c]	4[c]
Dryland double cropping	probably none	17	9+4[d]	1+3[d]
Summer ploughing	18	—	18	6
Improved drainage furrows	0	18	2	0
Broadbeds	0	18	0	0
Dry *kharif* sowing	0	8	1	0
Improved seed	3	13	16	4
Use of chemical fertiliser	4	11	15	5
Using recommended dose of fertiliser	—	—	4	1
Mixing seed and fertiliser	All who use fertiliser at seeding time			
Row seeding *kharif* crop	1	14	14	5
Chemical plant protection	1	6	7	6
Use of wheeled tool carrier	0	18	0	0

a = ICRISAT field trials began in 1982.
b = Includes wet and dry land.
c = Including those growing soybeans on land that can be irrigated, 23 of the 25 farmers grew soybeans in 1986-87.
d = The second number indicates the number who planned to double crop but had to fallow in the *rabi* season because of moisture constraints.

support the farmers' interest in double cropping. Some *rabi* crops are more tolerant of low moisture than others (no farmer out of the 25 was double cropping with wheat). The farmers will be more willing to risk a *kharif* crop when the planned *rabi* crop on the same land is not part of their subsistence production. Moisture will vary with field location (soil type and top vs. bottom of watershed). Finally, average gross income figures cited above indicate that a double cropping success rate of one year in three (Pandey's conclusion) will produce gross income at least equal to three years of single crops as well as a successful *kharif* crop every year.

In 1986-87, 17 of the 25 interviewed farmers intended to double crop 20 per cent of the total dry crop land operated by the 25 farmers. Ten of them actually did double crop 12 per cent of the land but the others decided not to plant *rabi* crops because of the unusally poor moisture conditions in October 1986. Although 1986-87 turned out to be a poor year for dryland double cropping, the farmers were stimulated by the field trials to learn how to make it work and can be expected to continue trying since potential net income benefits can be substantial (Sangle and Sharma, 1985).

These farmers in Begumgunj are large (averaging 28 acres of operated land) and well educated. They have both the resources and the understanding of innovation to facilitate the development of double cropping skills, based on the field trial experience with the technology package and their own knowledge of the production environment.

The attempted level of double cropping (20 per cent of dryland) is feasible with current production technology and farming systems. The development objective, however, is double cropping of all dryland with suitable soil and climate characteristics. As the farmers experience double cropping success and expand the percentage of crop land with two crops, they will begin to experience a number of constraints to further expansion. This paper identifies the constraints mentioned by the 25 farmers. Others may exist but were not mentioned by the farmers. Each of the constraints discussed will have its impact on individual farms differently but, with current practices, all farms will need to stop double cropping expansion well short of all dryland. The order of the discussion of these constraints has no significance.

Subsistence Production

Although the farmers in our sample averaged 28 acres per farm, all but two plan to produce foodgrains needed by their families and fodder needed by their livestock. Their priority in cropping decisions is to provide for these needs plus a safety factor to cover yield uncertainty. They respond to income increasing opportunities only with land and other resources not needed for producing these subsistence needs.

A partly informed person might see an opportunity rather than a constraint for double cropping here. Traditional food and fodder crops are nearly all *rabi* crops and will not directly conflict with a crop in the preceding *kharif* season. To minimise subsistence food and fodder crop failure, however, the farmers do not grow a prior *kharif* crop on land allocated to these crops. Adequate moisture conditions for a *rabi* crop (especially wheat) following a *kharif* crop, have a low probability (Pandey, 1986). A *rabi* food and fodder crop following the tradional *kharif* fallow, on the other hand, is generally expected to be successful. Only five of the 25 farmers expect any failure and only two estimated as high as three years of failure in ten. Land used for subsistence production will not normally be double cropped because of the food security risk.

The soybean/pigeon pea intercrop contributes to subsistence production. Some farmers, however, said they prefer *rabi* subsistence crops to pigeon pea to the extent that they will pull out immature pigeon peas in October and plant *rabi* crops if moisture conditions permit.

The area allocated to subsistence crops will vary with the size of the family, number of livestock and other factors. The farmers in our sample used an average of about one-third of their 28 acres for subsistence production. On smaller farms, the subsistence requirement will be much more constraining for double cropping.

A seldom mentioned aspect of subsistence production is the supply of fodder for livestock, often mentioned by the farmers in the same sentence as family food needs. It may actually be more compelling in cropping decisions than family food, which could be shipped in and obtained from the market if necessary. Fodder cannot be shipped in except at enormous cost and with doubtful supply.

While the *kharif* soybean crop does produce some fodder (less than one-fourth the feeding value of wheat straw per hectare), an adequate supply of wheat straw is considered essential by the farmers. This constraint to double cropping will decline in importance with increasing dependence on tractors, a process that seems well under way in Begumgunj. Eighteen of the 25 farmers use tractors and six of these own no bullocks. In areas of smaller farms and less tractor work, and with less crop land per bullock pair, the assured fodder constraint could dominate resistence to large scale double cropping.

Time Constraints for Kharif Sowing

For successful sequential crops, timely sowing of the *kharif* crop is critical. The crop must get started as early as possible in June, so it can be harvested and the sequential crops sown before October soil moisture becomes inadequate. Intercrop planting may be somewhat less restricted because the timing of *rabi* planting is not a problem but intercrop planting must also be completed in a timely fashion.

The *kharif* land preparation and sowing period is typically only three weeks long. Yet in this period, heavy rains can cause waterlogging or delayed rains can cause dry soil. Both will delay sowing while the farmers wait for favourable soil conditions. The farmers sometimes run out of time with current levels of *kharif* cropping. This would happen more frequently with large scale *kharif* cropping.

Several indications of timeliness problems were mentioned by the farmers. They reported crop failures from late sowing and unplanned tractor hiring to get *kharif* sowing done on time. The largest *kharif* area reported by a tractor farmer was ten hectares but he fallowed the land in the *rabi* season. The largest *kharif* area planted with bullock power was 2.7 hectares but the *kharif* soybeans failed. One bullock farmer grew two hectares of soybeans and expected a 50 per cent *rabi* crop which must be considered a good performance for 1986-87. A tractor farmer reported six hectares of soybeans followed by fair to good *rabi* crops.

Timeliness of *kharif* sowing will be less of a constraint on small farms. For instance, the bullock farmer mentioned above had double cropping success on two hectares.

Time Constraints for Rabi Sowing

The strength of this constraint differs between intercrop and sequential crop double cropping. The soybean/pigeon pea intercrop involves only soybean harvesting and threshing in September with no additional seed-bed preparation. Sequential cropping, on the other hand, requires harvesting and threshing plus seed-bed preparation and *rabi* planting in the short window of time between *kharif* crop maturity and soil too dry for planting. Sequential double cropping beyond the 1986-87 level of eight per cent of total dryland will result in greater timeliness problems. Even at this level, two of the six farmers with sequential crops failed to complete their *rabi* sowing on time.

The double cropping level at which this constraint would begin to cause problems, assuming current technology, is unclear but probably would be below 50 per cent of dryland. Even when labour is available, the number of bullocks, tractors and cultivation equipment will limit the amount of labour that can be used effectively. This constraint might be less severe on small farms with less land to cover and more family labour per hectare. Faster harvesting and sowing technology, relay sowing, and a system to delay *kharif* threshing until after *rabi* sowing, would all help relieve this constraint.

On larger farms, a possible way to expand double cropping with a given labour, draft power, and equipment supply would be to plan as large an acreage of sequential crops as could be managed in the *rabi* planting season (including soybean harvest and threshing from intercropped land). Then add to that as much additional intercropped land as could be planted in the *kharif* season once the sequential crop land was *kharif* planted. No farmer in the sample was using this combination.

Rotation Requirements

The farmers are generally aware of the benefits of crop rotation. The problems identified with lack of rotation were: more insect and disease damage, more weeds, and hardening of the soil. One farmer said double cropped fields must be fallowed every third year to maintain fertility, a double cropping cost which is not considered in year-by-year profit calculations. Another asked us to suggest a *kharif* crop to be rotated with soybeans. He required it to be as remunerative as soybeans.

The farmers follow traditional practice in rotating their *rabi* crops. *Kharif* soybeans are rotated with *kharif* fallow. Because chickpeas and lentils are the preferred sequential crops after soybeans (they are more tolerant of moisture stress than wheat), one can assume that the *kharif* crop will tend to be grown on fields to be rotated into commercial production of these two crops in that year. Wheat, the major *rabi* crop, will tend to follow *kharif* fallow at least with current perceptions of risk.

In the study year, the 25 farmers used 48 per cent of their *rabi* crop land for wheat and wheat/chickpea mixtures. Sole chickpeas and lentils occupied 42 per cent of *rabi* crop land. With current land allocations to the several *rabi* crops, double cropping of sequential crops is unlikely beyond 50 per cent of all crop land because of rotation constraint.

A combination of the soybean/pigeon pea intercrop and sequential cropping on the same farm would add to the number of alternatives to be rotated, an advantage for pest control and soil management but a greater management challenge.

Small farms, where subsistence crops dominate, will have low flexibility for meeting rotation requirements. Larger farms have more flexibility for working out rotation systems which respond to profit opportunities. Double cropping rotation recommendations in both situations would probably be welcomed by the farmers.

Kansgrass (Saccharum Spontaneum)

Kansgras serious perennial weed in the Begungunj area. The farmer's view of it is given by the market for crop land. In the study area, typical crop land sells for about Rs.20,000 per hectare. The same land, infested with kansgrass, sells for only Rs. 12,500 per hectare. In the village of Sumer, next to Begumgunj, one-third of the crop land is infested.

Infested land cannot be *kharif* cropped and is unavailable for both sequential and intercrops. The grass must be frequently knocked down during the *kharif* season to weaken its vitality. With this treatement, its growth is subdued during the *rabi* season and reasonable crops can be obtained. This grass eliminates substantial acreage from double cropping and limits the flexibility of rotations for double cropping on the remaining land of the farm.

The problem of this grass has long been recognised and both indigenous and scientific approaches to its control have been developed. None has worked well enough to become widely used. Some people accept the hypothesis that the grass thrives in low fertility soils and will die out if fertility and organic matter content are improved. This hypothesis could be easily tested. If valid, the research challenge would be to develop a system, feasible in the realityof the village, foe improving soil fertility and organmic matter. If the hypothesis is invalid, successful research on a truly effective and feasible control of this weed would have large benefits.

Long-Term Fertility Management under Double Cropping

Some farmers expressed concern about fertility and soil management under large scale double cropping. Their current answer to this issue is periodic fallow. With increased levels of double cropping, this concern may discourage the farmers from further increases. Research on this issue, followed by careful recommendations to the farmers, would contribute to the growth of double cropping.

Overcoming Constraints

Approaches to eliminate or reduce the constraints mentioned could be suggested by appropriate scientists. Most suggestions will require applied research about their effectiveness and their potential for fitting into the on-going agricultural system in which they are to be used.

An illustration from this study of the possible complexity of this task can be cited. The farmers said one of the attractions of *kharif* soybeans was the income they produce in September which can be used to pay for *rabi* inputs. A scientist might develop a method of delayed soybean threshing until after *rabi* sowing to relieve the seasonal time constraint. The farmers might not adopt it until a two-season input credit programme was available since the soybeans could not be sold until after the *rabi* inputs were purchased.

In addition to its complexity, the farming system is dynamic. The increasing use of tractors and associated implements, farmer attitudes toward subsistence and commercial production, use of new varieties and purchased inputs, labour availability, irrigation use, government programmes and a host of other factors are constantly changing in the modern village. Such change may reduce the power of some constraints for double cropping. Those involved with successful expansion of dryland double cropping must not only recognise and work to overcome existing constraints but also become aware of how on-going system change will affect double cropping opportunities.

This requires close interaction with the farmers and frequent travel between the experiement station and village with the objective of knowing as much or more than the farmers about what they do and why they do it.

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