Results similar to those shown in Table 3.4 were obtained in the other integrated studies. Based on these data, it was decided to make a separate recommendation for late plantings. This recommendation would use 30 kg less nitrogen per hectare and 10,000 fewer plants per hectare than the recommendation for early plantings. For soils with a compacted horizon, a small reduction in the phosphorus rate was also recommended for late plantings.

A fifth approximation of the recommended production practices for maize was calculated at the end of 1970, taking into account all information available at that time. Distinct packages of practices consisting of rates of fertilization and plant density were recommended for 16 producing systems, varying mainly because of differences in soil morphology, planting date, and use for fruit trees.

Bush bean yields in the six experiments were influenced by rates of fertilization and plant density. Average optimal levels were 67 kg/ha N, 53 kg/ha P_2O_5, and 112,500 plants/ha. The average yield obtained with the optimal treatments was 1,951 kg/ha beans. When no fertilizer was used, the average yield was 780 kg/ha. The cost of the average optimal treatment was equivalent to 605 kg beans with a price of $0.12/kg and to 363 kg beans with a price of $0.20/kg. Even at the lower price for beans, which rarely occurs, the average increase in yield using the optimal treatments was almost double the cost of the treatments.

These data were used to arrive at a first approximation of production practices for bush beans: (a) for deep soils of Popocatépetl and soils with a compacted horizon: 60 kg/ha N, 60 kg/ha P_2O_5, and 120,000 plants per hectare; and (b) for the soils of La Malinche: 60 kg/ha N, 30 kg/ha P_2O_5, and 120,000 plants per hectare. The recommendations of the National Agricultural Research Institute for the control of the bean beetle, *Epilachnia varivestis* (known locally as "conchuela") were to be followed, with the farmer to select the variety, the date of planting, and the time to cultivate.

Results obtained in the study of the maize-bean association indicated that this cropping system might provide greater net income to Puebla farmers than either maize or beans grown alone.

FIELD RESEARCH IN 1971

Integrated studies of the effects of planting date, fertilization, and plant density were continued at four locations in 1971. It was decided to continue these experiments for several years to accumulate information on the interaction between these factors and climatic conditions.

Data from the integrated studies conducted in 1970 indicated that investigations of efficient management practices for late maize planting should take these factors into account: (a) existing short-season varieties have a relatively low-yielding ability, as compared to long-season varieties; (b) there are probably nutrient deficiencies other than nitrogen and phosphorus; and (c) light intensities and temperatures are relatively low, and available soil moisture abundant, in the initial stages of plant growth.

Three experiments were conducted at a single location in 1971 to determine optimal production practices for late plantings of maize. These experiments covered three topics: (a) exploration of the yielding ability of six varieties, (b) study of the response of a local maize variety to five minor elements, and (c) study of the response of an introduced maize variety to fertilization with nitrogen, phosphorus, and chicken manure, and to plant density.

The response of maize to five rates of nitrogen and phosphorus or nitrogen and plant density was studied at 10 locations to produce data for calculating the most adequate mathematical model to represent maize response to these factors (thesis research of a graduate student at Chapingo).

Experiments at six locations studied optimal levels of fertilization and plant density for bush beans. Two experiments compared net income from the maize-bean association with that obtained from maize and beans grown alone (pole beans were used in one experiment and bush beans in the other).

A series of experiments at two locations sought to identify crops that might be grown instead of maize in years when the rains do not begin until July. Maize planted as late as July runs a high risk of being damaged by frost in the fall. Included in this series were sunflowers for forage, bush beans, horse beans, oats, barley, and maize.

Results: 1971

The rainfall pattern in 1971 was quite favorable for both maize and beans. In the maize experiments, the average numbers of days with plant wilting were 8.7, 0.4, 0, and 0 for the four parts of the growing cycle. Slight to severe hail damage occurred in the first, second, or third parts of the growing cycle in 10 maize experiments. Slight to severe frost damage occurred in the first part of the growing cycle in four maize plantings. None of the bean experiments was damaged by drought, hail or frost. Bush beans suffered moderate leaf damage due to anthracnose disease at three sites.

Only one of the early-maturing maize varieties studied in 1971, Rojo Salvatori, showed a reasonably high yielding ability. Table 3.5 compares this variety with Zacatecas 58, which had the next highest yields. The Rojo Salvatori yield at the highest level of fertilization and plant density was

TABLE 3.5. Grain yields obtained with two early-maturing maize varieties receiving different fertilization and plant density treatments.

Nitrogen kg/ha	P_2O_5 kg/ha	Population density plants/ha	Chicken manure ton/ha	Grain yields (kg/ha) using: Zacatecas 58	Rojo Salvatori
60	50	40,000	0	1237	1448
100	50	60,000	0	833	1840
150	80	80,000	0	1168	2870
120	80	80,000	10	2030	2537
200	100	100,000	0	1098	1676
200	100	120,000	0	1563	1354
150	100	120,000	20	1491	3147
150	100	150,000	20	2597	4317