Pheasants in relation to Amish and modern farming methods in Buchanan County, Iowa

by

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INTRODUCTION

In terms of the annual harvest, the ring-necked pheasant (*Phasianus colchicus*) is Iowa's most important game bird. Consequently, it has been extensively studied by the Iowa Cooperative Wildlife Research Unit and Iowa State Conservation Commission personnel. Results of these studies indicate that pheasant populations are closely related to habitat (Klonglan 1962). Since most of Iowa is intensively farmed, habitat is generally related to land use and agricultural practices, but the limiting effects of specific farming methods are not yet fully understood. To further this understanding, this project was undertaken by the Research Unit to evaluate pheasant populations on areas with marked differences in their basic style of agriculture.

One of the oldest and most unique types of farming still found in Iowa is that practiced by the Old Order Amish near Hazelton, Buchanan County. The Amish are a religious sect who believe in frugality, hard work and tradition. As a result, they have remained bound to the ways of their ancestors and have rejected modern ways of life. This is most apparent in their method of farming. They rely totally on horses to do all of their field work, which restricts their farming techniques; hay is put up loose, oats are threshed rather than combined and corn is husked by hand. The type and acreage of crops they plant are also affected. All possible tillable land must be put into production to feed the large livestock herds required to farm in this manner. Thus, crops are grown for direct consumption rather than cash sale, and no land is included in government land retirement programs.

Buchanan County was selected as the site for this study for two reasons. It contains a relatively homogeneous colony of Amish farmers settled among non-Amish "modern" farmers, and is located in part of the best pheasant range in east central Iowa. The objectives of the study were: 1) To compare pheasant populations, nesting and production on Amish and non-Amish farm lands, 2) relate any differences and/or similarities to agricultural practices, land use or any other factors that might be discovered and 3) relate any differences in populations to use or non-use of agricultural chemicals on Amish farms. To accomplish these objectives, two pheasant research areas were established - an Amish Area comprised of land owned mainly by Amish farmers, and a nearby Check (control) Area on land owned exclusively by farmers using modern farming methods. The study was begun in the summer of 1968, but was interrupted in December of that year when the investigator was inducted into military service. Studies were resumed in September, 1970, and continued through the winter of 1972. Full-time field research was conducted only during the summers of 1968 and 1971. Research activities during the rest of the year were limited to week-end field trips whenever necessary.

Identification of all animals and plants in this report is by common name, with scientific names listed in Appendixes I and II.

PHEASANTS AND FARMING METHODS

Land Use

Since the introduction of the ring-necked pheasant into the north central states in the early twentieth century, wildlife biologists have attempted to explain patterns of pheasant distribution and abundance in many ways. Various authors have attributed the limits of the best pheasant range to soil fertility (Baumgras 1943, Nelson 1952), specific soil nutrients (Leopold 1931, McCann 1939, Dale 1955), climate (Graham and Hesterberg 1948, Yeatter 1950) and the seasonal effects of weather (Allen 1956, Kimball 1948, Erickson et al. 1951). None of these theories has adequately explained the failure of the pheasant to extend its range, or fill in voids in its present range, where suitable habitat appears to exist.

Regardless of the specific factors which influence pheasant distribution, it is apparent that the ring-necked pheasant is primarily a bird of agricultural lands and does best where moderately intensive farming is practiced. Leopold (1931) stated that on its native range in China, the pheasant was associated with dense reed beds along rivers and lines of cover on paddy dikes, always on or near farming lands. Kimball et al. (1956), in describing typical pheasant habitat in the prairie region of the United States, stated that "Throughout the region, wherever food, winter cover and nesting and brood cover are found well dispersed, and in good association, pheasants usually thrive." They described the best pheasant habitat as having:

1. Fifty to seventy-five percent of the land cultivated.
2. The average farm size from one-quarter to one section.
3. A good year-around supply of food (corn, small grains and weed seeds.
4. A relatively high percentage of idle or waste land.
5. Moderate to light grazing.
6. The non-agricultural land having one, or a combination, of shelter belts, weeds, slough margins, plum or willow thickets.
7. Few dairy cattle or sheep, and feeding of beef cattle in feed lots.

A general description of the land where such conditions exist was supplied by Wagner and Besadny (1958). "The general pattern of good pheasant range, then, is open country that is flat to gently rolling. Soils are usually very fertile, and much or most of the land is under the plow. Often, but not always, there is some type of wetland or lowland in the form of marshes, drainage ditches or irrigation."

Within this broad framework, a wide range in variation of habitat types exists among the pheasant producing states in the Midwest. The actual amount of cultivated land within the best pheasant ranges has been reported as 75 to 95 percent in Ohio (Leedy and Hicks 1945), 95 percent in Illinois (Robertson 1958), 95 percent in Indiana, compared to 30 percent on its poorest range (Ginn 1962) and 55 to 70 percent in Wisconsin (Frank and Woehler 1969). Specific habitat requirements of pheasants for nesting, brood and winter cover have resulted in certain patterns of land use being more valuable to pheasant production than others. Dale (1955) found that populations of 50 pheasants per 100 acres were produced in Pennsylvania where 48 percent of the land was in row crops (corn and soybeans), 20 percent in hay, 15 percent in oats, 10 percent in pasture and less than 10 percent in farm lots and waste. Deubbert (1959) stated that areas of South Dakota producing 120 birds per section had four times as much marsh, twice as many fence-rows and more idle land than areas with 15 birds per section. Indiana's best pheasant range has 20 percent of the land in corn, 20 percent in small grains, 10 to 20 percent in hay and rotation pasture and less than 9 percent timber and waste (Ginn 1962). In a study of the 10 best pheasant producing counties in Illinois, Labisky et al. (1964) found that 45 per-cent of the land was in corn and soybeans, 25 percent in small grains, 5 percent in hay and 12 percent pasture. The number of pheasants seen per mile on roadside counts in these counties was significantly correlated positively with the number of farms in cash grains, and negatively with the amount of wood-lands. Wisconsin's best pheasant range produces a harvest of about 20 cocks per section and has 20 to 40 percent of the land in corn, 20 to 35 percent hay, 20 to 35 percent pasture, less than 10 percent woodlands and the remainder in wetlands (Wagner et al. 1965). In Minnesota, the best range contains 48 percent corn, 16 percent soybeans, 8 percent each in hay, oats, pasture and diverted acres and less than 5 percent waste (Chessness et al. 1968). The pheasant densities reported in these studies are not directly comparable because of the different methods by which they were determined. This makes it impossible to devise an optimum ratio of habitat types required to produce good pheasant populations. These studies do, however, indicate that the ring-necked pheasant has adapted to many combinations of cover types, and can thrive wherever its minimum requirements of food and cover are met. Wagner and Besadny (1958) attributed this to the fact that the pheasant did not evolve in North America, and is thus not dependent on any particular habitat type.

Pheasant research conducted by the Research Unit has been mainly concerned with nesting studies, winter behaviour and movements in northern Iowa, and the effects of soils and production on populations in central Iowa. Land use, in most cases, has been reported only in conjunction with habitat preferences for nesting or winter cover, and not to explain pheasant densities. Baskett (1947) reported that 91 percent of the land on the Winnebago County Pheasant Research Area in 1939 was cultivated, with 32 percent in corn and soybeans, 32 percent small grains, 14 percent hay and 9 percent waste. At the time of Baskett's study, Winnebago County was in the heart of Iowa's prime pheasant range. Klonglan (1962) found that the Winnebago Area had a pheasant population of about 125 birds per section from 1957 to 1959. At that time, 93 percent of the land was cultivated, with 64 percent in corn and soybeans, 19 percent small grains, 8 percent in hay, 2 percent pasture and 7 percent waste. An area with similar populations in southern Iowa was only 86 percent cultivated, with 35 percent in corn, 14 percent small grains, 12 percent hay, 25 percent pasture and 14 percent waste. Three areas in central Iowa with similar land use patterns (51 percent row crops, 22 percent small grains, 12 percent hay, 6 percent pasture and 8 percent waste) produced 80, 40 and 11 birds per section in 1960 (Bolstad 1962), and the differences could not be attributed to land use. Lyon (1965) and Egbert (1968) found similar results during later research projects on the same three areas. In Iowa, then, as in other pheasant states in the Midwest, no direct relationship has been established between a specific land use pattern and a given number of pheasants which it can be expected to produce.

Two recent trends in land use - intensive farming and government land retirement programs, have had opposing, but unequal, effects on pheasant populations. Chessness et al. (1968) stated that "Increased intensive farming in Minnesota's primary agricultural range has adversely affected pheasants, most importantly by reducing undisturbed nesting cover." Faber (1948) found that the number of pheasants seen on roadside counts in Iowa was directly proportional to the amount of land in good nesting cover (hay, oats and waste) in each county. More importantly, where undisturbed nesting cover was eliminated, pheasant populations decreased. He attributed the loss of undisturbed cover to an increase in intensive farming caused by higher prices for corn and soybeans. The decline in pheasant populations in Wood County, Ohio, since 1947, has been blamed on the loss of prime nesting cover (Leite 1971). The total agricultural acreage increased at the expense of odd corners, wetlands and woodlands. On cultivated land, soybean acreages increased greatly, with a corresponding loss of oats and hay. Warnock and Joselyn (1964) attributed the first discovery of pheasant nests in soybean fields in Illinois to the loss of traditional nesting cover caused by more intensive farming.

The trend to placing land in government land retirement programs may have served to partially offset the loss of undisturbed cover. A study of pheasant populations in five Midwest states (Iowa, Minnesota, Nebraska, North and South Dakota) showed that increases ranged from 17 to 96 percent between 1958 and 1959, and corresponded to increases in soil bank acreage (Schrader 1960). The greatest increases were recorded in counties having more than 5 percent idle lands. Joselyn and Warnock (1964) estimated that the Federal feed grain program contributed about 35 percent to pheasant production in Illinois, on lands that would ordinarily have been cropped, or about 215 birds per 1,000 acres retired. A population increase of 10 percent on intensive nest searching areas in Wisconsin was attributed to the same program (Gates and Ostrom 1966). Nomsen (1969) warned, however, that the programs were not unqualified successes. The Conservation Reserve and Cropland Adjustment Programs (CAP), which called for long-term retirements, were beneficial because cover remained undisturbed. The annual programs called for clipping of weeds prior to July 15, and resulted in much nest destruction. In 1968, the deadline for mowing was extended, possibly increasing the value of even temporary retirements. Leite (1971) reported that CAP lands in Ohio were often left fallow, and as such were worthless to pheasant production.

Agricultural Practices

In addition to land use practices, several specific farming techniques have a direct effect on pheasants and pheasant populations. One of the most destructive farming methods to both hens and nests is the mowing of hay. The early emergence of hay results in much early nesting in hay fields, before other cover types become available. Baskett (1947) estimated that 85 percent of all nests in northern Iowa were established in hay fields. Mortality rates are greatest to hens and juvenals and can exceed 50 percent of the total population under certain conditions (Thompson 1964). Erickson et al. (1951) estimated that mowing was the single most destructive agent to pheasant nests in Minnesota. The trend toward greater mower speeds and earlier cutting of hay have increased the percentage of nests destroyed in many areas. Bue and Ledin (1954) found that tractor-drawn mowers killed twice as many hens as horse-drawn mowers. Mill cutting, involving high speeds and night mowing, caused a three-fold increase in mortality in Ohio (Dustman 1950). The trend to growing alfalfa, rather than red clover, is a cause of greater mortality, because alfalfa matures earlier and mowing occurs during the peak of the nesting season (Wagner et al. 1965). Numerous authors have experimented with flushing bars to warn pheasants of the approaching mower. Bue and Ledin (1954) recorded a 50 percent decrease in mortality when flushing bars were used, but other studies have obtained mixed results. Robertson (1958) and Zorb (1957) found that bars were not effective at speeds in excess of 5 mph. Attempts to use motor exhaust or other auditory stimuli to flush birds have also proven ineffective (Stewart and Dustman 1955, Zorb 1957). Klonglan (1955a) found that the Ohio flushing bar was superior to other types under Iowa conditions, and that the bar was most effective in heavy cover. The harvest of oat fields is generally less destructive, because most clutches of eggs have hatched by that time, and the greater height of the cutter bar causes fewer injuries (Wagner et al. 1965).

Spring plowing and preparation of seed beds can cause nest destruction and mortality, depending on crop phenology (Robertson 1958). In early springs when the weather is favorable, a few early nests are destroyed, usually prior to incubation. When this occurs, renesting is prompt and the effects on the population are minimal. When bad weather delays plowing, incubating nests may be destroyed, delaying renesting for a considerable period and affecting the hatch. Spring burning of sloughs and waste areas has much the same effect (Macmullan 1954, Erickson et al. 1951). Nomsen (1969) reported that fall plowing may decrease the quality of strip cover for nesting. Loose soil blown by the winter winds accumulates in fencerows and ditches and covers residual vegetation. The most important effect of fall plowing, however, is in decreasing available food and cover (Leite 1971).

Excessive concentrations of livestock and overgrazing are detrimental to pheasant cover. Labisky et al. (1964) found a significant negative correlation between the number of pheasants seen on roadside counts and the number of livestock farms in Illinois. Overgrazing of woodlots and sloughs reduces their effectiveness as nesting and winter cover (Wagner et al. 1965, Erickson et al. 1951). Ginn (1962) estimated that the maximum livestock concentration that good pheasant habitat in Indiana could tolerate was 220 head per section.

New methods of corn harvest may have an important effect on pheasant populations. Baumgras (1943) found that mechanical pickers leave significantly more corn in the field than hand husking. Standing stalks provided better cover than those left by mechanical pickers unless stalks were shocked, in which case little food or cover was left. Foraging by livestock in picked fields also served to reduce waste corn. The most damaging method of harvesting is probably silage cutting, which leaves no food or cover (Macmullan 1954).

Other farming methods may have an important impact on pheasant populations in certain circumstances. Wagner et al. (1965) found a significant positive correlation between the amount of wetlands drained and declining pheasant numbers in Wisconsin. Sloughs and marshes have been important for both nesting and winter cover (Nelson 1950, Weston 1954). The switch from drainage ditches to tile drains also tends to eliminate cover areas (Leite 1971). Macmullan (1954) stated that the invention of the rubber-tired manure spreader proved to be important for Michigan pheasants. It permitted farmers to spread manure all winter long and proved to be an excellent source of winter food in some areas.

Pesticides

One agricultural practice coming under increasing criticism because of its effects on the environment is the application of chemical sprays for the control of plant and insect pests. Investigations into the effects of chemicals on ring-necked pheasants are generally in the early stages. Most studies have been concerned with establishing lethal doses of various pesticides in penned birds, and few have progressed to the stage of field studies following actual applications. Lilly (1940) found that juvenile pheasants were not affected by arsenical grasshopper poisons at the application rates recommended or commonly used. Seven common fungicides used in treating seed corn had no serious immediate effect on penned pheasants (Leedy and Cole 1950). The authors estimated that field applications would have to be increased ten-fold to equal test rates. Erickson et al. (1951) found that 10 mg per kg of body weight of Cerusan M or Simesan, Jr. (mercurial disinfectants) was lethal, but that this dosage exceeded field applications by ten times. Genelly and Rudd (1956) found that dieldrin, DDT and toxaphene were ranked in that order of toxicity to pheasants, but that field dosages had no apparent lethal effect on the test birds. A dose of 500 ppm of DDT fed to breeder pheasants in California for 13 weeks was highly toxic, but doses of 100 ppm or less were not (Azavela et al. 1965). More than 56 percent of wild-trapped pheasants in California had less than 100 ppm of DDT in fat tissues, and Hunt (1966) concluded that DDT was not a health hazard. Keith and Hunt (1966), however, warned that too little is known to be able to determine with confidence either the intensity of exposure or effects of insecticides on wild animals from residues in tissues alone.

One of the earliest field studies found that pheasants in Wisconsin were not likely to be affected by residue levels of

DDT, toxaphene or chlordane in fields there (Wisconsin Conservation Department 1950). Tigner (1960) reported that Colorado pheasants were not adversely affected by applications of aldrin, dieldrin, heptachlor, DDD, endrin, parathion or toxaphene. Applications of 2 lb. per acre of technical aldrin over large blocks of land resulted in 25 to 50 percent adult mortality and depressed reproduction in Illinois (Labisky and Lutz 1967). Reproduction returned to normal the following year, however, and restored the original population level. Gill and Verts (1970) found only 1 ppm or less of DDT in soil samples from test areas sprayed with 2 lb. per acre for six years. Birds wild trapped on these areas were seemingly unaffected, but were more susceptible to forced feeding of DDT than controls. Gill et al. (1970) also found that DDT was twice as lethal as DDE, and that degeneration of DDT to that analog would be beneficial to wild birds. Residues of 1 ppm of dieldrin developed in soils and insects in fields in Missouri sprayed with 1 lb. per acre of aldrin for 15 years (Korschgen 1970). This low concentration was thought to be harmless to adults, but was potentially dangerous to juvenile pheasants because of their increased insect consumption.

These studies have shown that normal field applications of insecticides cause little immediate mortality to wild pheasants, but others indicate that some insidious effects may result. Azavela et al. (1965) found that hens fed 500 ppm of DDT passed on residues through the egg. No effects on egg production, fertility or hatchability were evident, but chicks had a lower survival rate than controls. Baxter et al. (1969) reported decreased hatchability and fertility in hens from eggs receiving dieldrin through the egg. Dahlgren and Linder (1970) reported no difference in eggshell thickness in eggs from hens receiving 10 mg of dieldrin for 13 weeks, but Dahlgren et al. (1970) found that chicks produced by these hens were less wary, had poorer coordination and were more easily captured by hand. Thus, it appears that the chemical insecticide sprays may have long-term effects on pheasant populations, even though no direct mortality may result.

Almost no work has been done on the effects of herbicides on pheasant populations. No reports were found of mortality, either direct or insidious, resulting from plant sprays. The only apparent effect seems to be on habitat destruction. Leite (1971) stated that clean farming, resulting from indiscriminate application of herbicides to fence rows and odd areas, was a contributing factor to the pheasant decline in Ohio.

DESCRIPTION OF THE STUDY AREAS

Location

Buchanan County is located in northeast Iowa, approximately 54 miles west of the Mississippi River at Dubuque and 66 miles south of the Minnesota state line. The pheasant research areas are located in north central Buchanan County within secs. 25, 26, 30, and 31, Hazelton Township (T.90N., R.9W., 5th P.M.); secs. 25, 26, 27, and 36 Fairbank Township (T.90N., R.10W., 5th P.M.); sec. 1, Perry Township (T.89N., R.10W., 5th P.M.) and sec. 30 Buffalo Township (T.90N., R.8W., 5th P.M.). They are at longitude 91° 55'W., latitude 42° 38'N., and are about 2 miles south of Hazelton, Iowa, and 8 miles north of Independence, Iowa (Fig. 1).

The Amish Area consisted of a 2,040-acre plot described by the W 1/2 secs. 30 and 31, Hazelton Township; secs. 25 and 36, Fairbank Township and the W 3/4 N 1/2 N 1/2 sec. 1, Perry Township (Fig. 2). Intensive research activities were conducted on this plot, but it was necessary to extend the pheasant call-count census route around the N 1/2 sec. 26, and the NE 1/4 sec. 27, Fairbank Township, in order to obtain a 10-mile route. This research area was located in the heart of an Old Order Amish colony, and the land is owned principally by Amish farmers.

A Check Area was established 3 1/2 miles east of the Amish Area on land operated exclusively by farmers who use

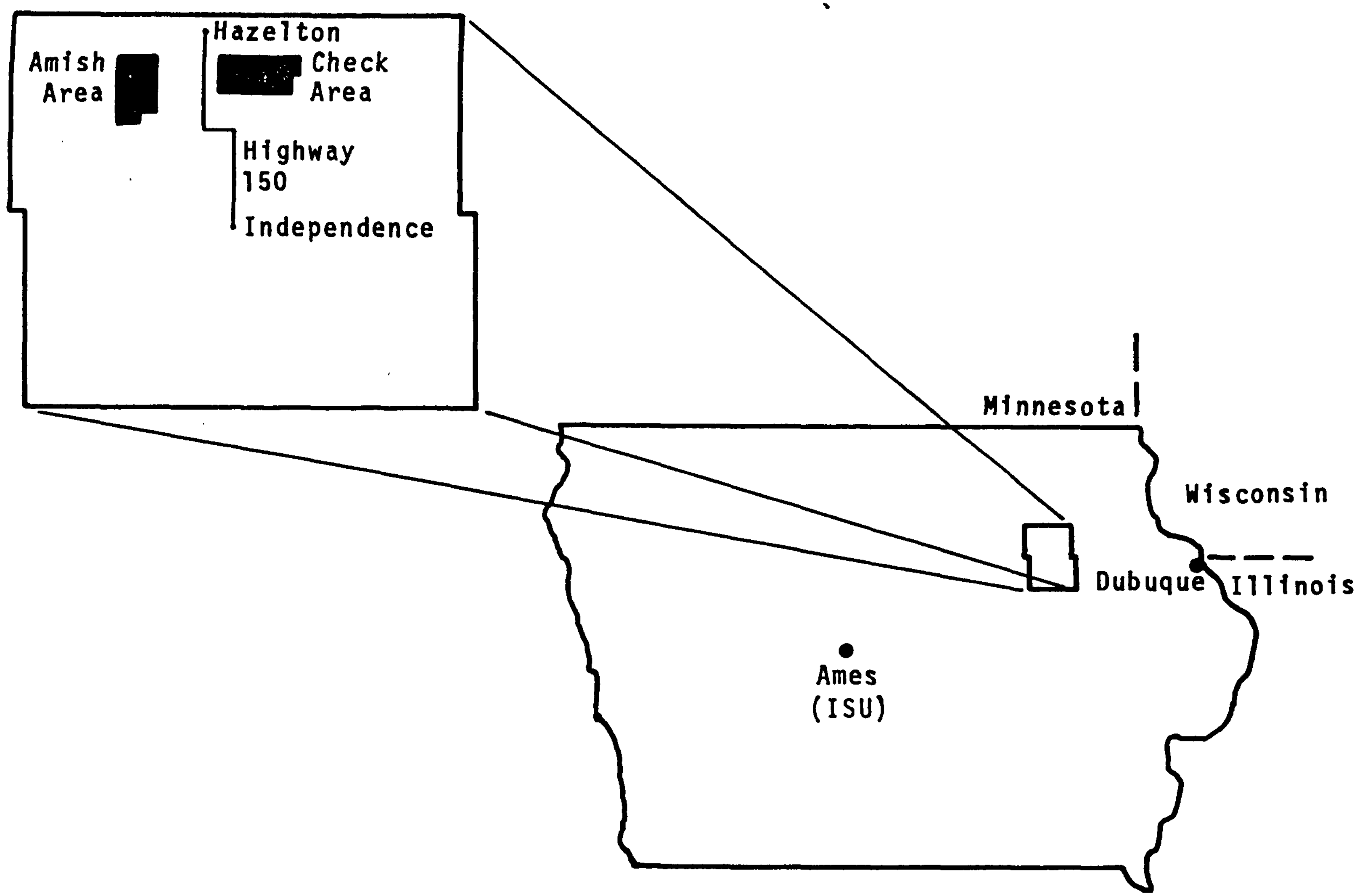

Figure 1. Location of the Buchanan County pheasant research area within the state of Iowa.

Figure 2. Aerial photograph of the Amish Area, 1970.

Figure 3. Aerial photograph of the Check Area, 1970.


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26
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modern farming methods. This area consisted of 1,776 acres, secs. 25 and 26, Hazelton Township and the W 3/4 sec. 30, Buffalo Township (Fig. 3).

These plots were chosen as research areas because of their plainly defineable boundaries, similar size and the availability of all-weather roads for census routes. Their proximity helped assure that soil types, weather or other environmental factors would not have a differential effect on their respective pheasant populations.

Geology

Buchanan County is covered by drift material from three major glaciations (Brown 1936). The Nebraskan glacier (750,000 years ago) and the Kansan glacier (500,000 years ago) deposited up to 100 feet of clay and boulders over the original bedrock, but this drift material has been covered again and has little effect on local soil formation. Most soils have developed from 10 to 20 feet of sand, gravel and boulders deposited by the Wisconsin glacier (14,000 years ago) and have changed little since. One of the striking features of these soils is the presence of small-to-large boulders which must be removed before field work can be accomplished.

Loess deposits were formed following the glacial periods, but were never extensive in Buchanan County and most have eroded away. Alluvial deposits have developed along the major drainageways, resulting in fertile terrace and bottomland soils subject to periodic overflow. Soils developed from drift materials are by far the most important, comprising 81 percent of Buchanan County, while alluvial soils make up 18 percent and loess soils 0.5 percent (Brown et al. 1932).

Topography and Soils

The general topography of the study areas is nearly level to undulating. Low swells alternate with broad, shallow swales, which are connected to form poorly developed drainageways. The absence of any significant streams or other natural drainageways has resulted in sloughs and swales, necessitating artificial drainage for satisfactory crop production (Brown et al. 1932).

Both study areas lie within the Kenyon-Floyd-Clyde soil association area (Oschwald et al. 1965). Kenyon-Floyd-Clyde soils are found in 21 northeast Iowa counties and form the second largest soil association in the state (10 percent of Iowa). Clyde soils are found on the nearly level portions of the upper drainageways. They consist of 18 to 22 inches of black or silty-clay loam over a clay-loam subsoil. Drainage is poor, but they provide the best cropland when tiled. Floyd soils occur on the lower slopes of 1 to 3 percent, and have 10 to 15 inches of black loam over grey to brown loam subsoils. Drainage is also poor, but water tends to run off onto the lower Clyde soils. Kenyon soils are found on the upper ridges and slopes of 1 to 15 percent. Topsoil is 9 to 14 inches of brown loam over a grey loam subsoil. Drainage, moderate to poor, is the best in any soil in this association.

Soils in this association are satisfactorily fertile for temperate zone crop production. All soils are acid in reaction and require periodic lime applications to maintain sustained crop yields (Brown et al. 1932). The soils are also uniformly low in plant available phosphorous and potassium and require fertilizer supplements of these nutrients. Other fertilizer requirements depend on the crop being raised (Oschwald et al. 1965).

Climate

The climate of Buchanan County is characterized by short, warm, moist summers and long, cold, dry winters, with wide fluctuations in the precipitation, temperature and freezing date normals recorded from year to year (Barger 1954). When normal climatic conditions exist, vigorous growth of corn, soybeans, hay, oats and other temperate zone crops is possible.

United States Weather Bureau data recorded at the Independence weather station (7.5 air miles southwest of the research areas) during the period 1931 to 1960 indicate the annual mean temperature for Buchanan County is 47.7° F. Monthly average temperatures range from 19.3° F. in January to 73.7° F. in July, with an average winter temperature (November to March) of 27.4° F. and an average growing season temperature (May to September) of 67.4° F. (Shaw and Waite 1964). Mean freezing dates for spring and fall are May 5 and October 5, respectively. The resulting freeze-free season of 152 days surpasses that required for corn production. These dates represent the average date of occurrence of the last spring and first fall freeze, and not the dates for a killing frost, so the actual growing period may be slightly extended (Shaw et al. 1954).

The average annual precipitation total is 32.45 inches, 70 percent of which falls during the growing season (Shaw and Waite 1964). About 4 inches of rain falls each month from May to September, averaging more than one-tenth inch per day. Precipitation during the rest of the year averages 1.7 inches per month, with winter snowfall accounting for about 50 percent (Midwest Farm Handbook 1969).

Weather

Temperature during both years of study tended to be subnormal (Fig. 4). Precipitation totals were more than 7 inches above normal in 1968 and below normal in five of the recorded months in 1971 (Fig. 5). An unusually mild winter in 1968 produced the lightest snowfall on record (12 inches) and was followed by the mildest spring since 1946. March and April temperatures averaged 1.4° F. higher than normal and were followed by low May rainfall, which allowed 98 percent of Iowa's corn crop to be planted by May 20, the earliest date on record. June, July and August were cool and wet. Temperatures aver-

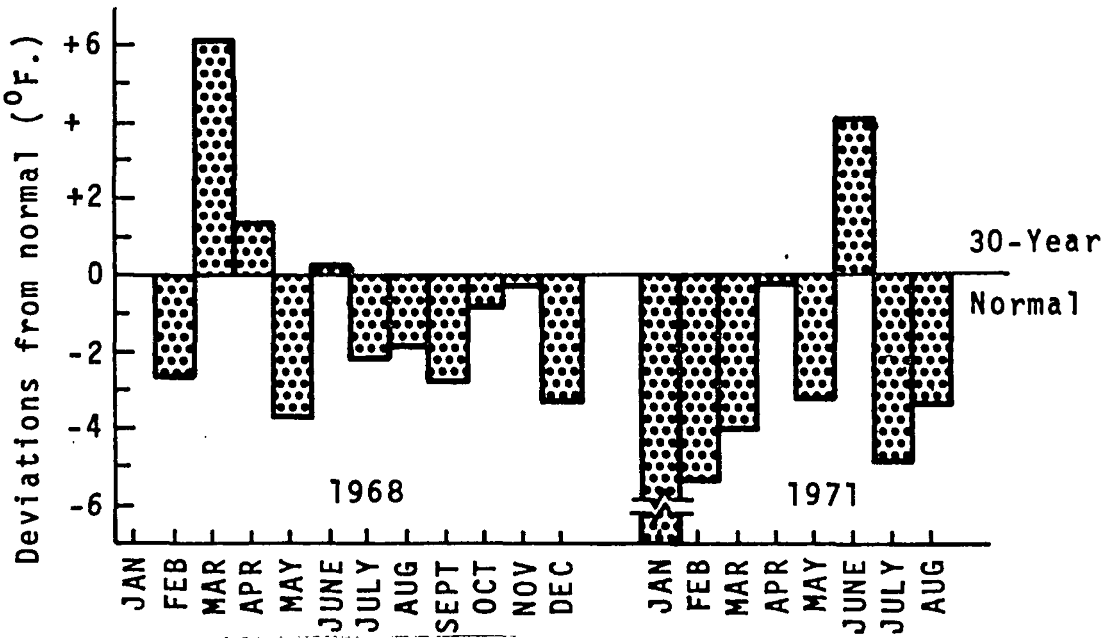


Figure 4. Deviations from the 30-year monthly temperature normals for the Independence, Iowa, weather station, 1968 and 1971.

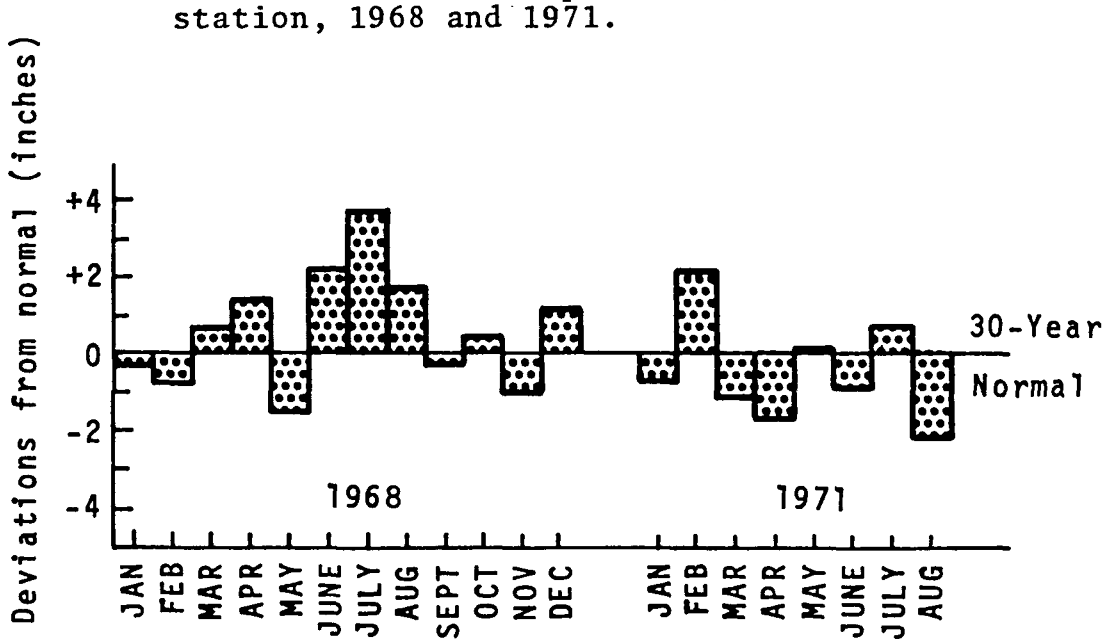


Figure 5. Deviations from the 30-year monthly precipitation normals for the Independence, Iowa, weather station, 1968 and 1971.

aged 1.2° F. below normal and all precipitation totals were at least 1 1/2 inches above normal, ranging up to 3.7 inches in July. Light to moderate showers fell throughout this period and rainfall in excess of one-tenth inch was recorded on 33 days. The most severe storm of the summer dropped 4.64 inches of rain on Independence on July 17. Dry Run Creek rose 4 feet in 7 minutes, and the Wapsipinicon River crested 2 feet above the previous flood stage record. Unofficial bucket surveys by weather bureau personnel indicated that 10 to 14 inches of rain fell directly on the study area in a 24 hour period on July 16 - 17. Buchanan County was declared an official disaster area as a result of extensive flood damage to roads and bridges, and access to the study areas was prevented from July 17 - 23. Cool temperatures in August combined with temporary pools of standing water to produce dense fog on 10 mornings (U.S. Department of Commerce 1968).

Freeze-free dates for 1968 were May 5 to October 5, producing a freeze-free season of 152 days.

The winter of 1971 was extremely cold and marked by severe blizzards. January was the fourth coldest in 30 years and a total snowfall of 31.8 inches in February was the greatest since 1915. Blizzards on January 4, February 4, 5, and 22 and March 18 and 22, kept a snow cover of greater than 20 inches at all times, produced huge drifts and prevented access to the study areas on several weekends. April and May were cool and dry, but a very hot June and cool July produced the biggest temperature reversal in history. Severe windstorms with winds up to 80 mph crossed Buchanan County on July 7 - 8, but no serious storms of the magnitude of July 1968, were produced. August was the driest in 99 years, but drought was not as severe as in western Iowa (U.S. Department of Commerce 1971).

The exact effects of these weather patterns on various phases of this study will be discussed in the appropriate sections.

Predatory and Game Fauna

Several species of birds and mammals seen on the study areas can be considered potential predators on pheasants, nests or eggs. Potential avian predators include the red-tailed hawk, marsh hawk, and rough-legged hawk. A single red-tailed hawk resided on the Amish Area and several sightings were recorded on the Check Area. Marsh hawk sightings were common, but only one rough-legged hawk was seen, and it was not considered a resident. One barn owl was seen, and a screech owl call was heard on several mornings. American crows were plentiful and considered potential nest predators.

Mammalian predators included the domestic cat and dog, striped skunk, red fox, opossum, raccoon, badger, fox squirrel, pocket gopher and Franklin's ground squirrel. Of these, only dogs, cats, raccoons and ground squirrels were sighted often enough to be considered potentially important. Skunks, badgers and foxes were seen only occasionally, while only one opossum sighting was recorded and fox squirrels were rare.

Few other species were plentiful enough on either area to be considered as game. Eastern cottontail rabbits were seen occasionally along roadsides, but only one sighting was made of a white-tailed jackrabbit. One pair of blue-winged teal found loafing in a shallow drainage ditch on the Amish Area were the only waterfowl seen on either area and were probably migratory. Mourning doves were common in farm groves, although they are not currently game birds in Iowa. Other typical Iowa game species such as the white-tailed deer and bobwhite quail were never seen on either study area.

A total of 28 species of non-game birds were observed on the Amish Area and 25 species on the Check Area (See Appendix I for a complete list). No attempt was made to compile a complete bird list, as observations were made during other field work, and no major differences were observed in the bird faunas, as most species were seen on both study areas. The bird list reflects the general vegetation types available on the study areas. Most common were those species associated with grasslands and prairies. Few marshland or forest species were observed, due to the lack of suitable habitat.

METHODS

Land Use

Agricultural land use

Detailed cover maps were made of both study areas as a basis for land use comparisons. Aerial photographs of the appropriate sections were obtained from the Buchanan County office of the Agricultural Stabilization and Conservation Service (ASCS), and permanent field boundaries were traced onto graph paper scaled one-tenth acre per square (Snyder 1966). Changes in field shapes and cover types between 1968 and 1971 were determined by direct observation. Field sizes were measured from the aerial photos when possible, or were paced in other cases. The total acreage in each field was computed to the nearest one-tenth acre by counting all the squares, or fractions of squares, within each field boundary. Cover type totals were determined by summing the field totals for each cover type, and acreages were converted to percentages of the total area for comparison purposes, due to the difference in size of the two study areas.

Road ditches

The major cover types and the drainage capabilities of the road ditches around the study areas were mapped to compare the amount of available nesting cover in each ditch system. A 50 percent sample was obtained by dividing each mile of ditch into one-tenth-mile plots using a car odometer, and mapping alternate plots (hereafter called segments). All major vegetation types were recorded, but the cover type used for mapping purposes was that comprising at least one-half of the vegetation in each segment. Combinations of the most abundant species present were used when dominance by any one species was not apparent. The drainage capability of each segment was rated on a scale of one to five, determined by the degree of wetness of the ditch bottom. The ratings were determined as follows:

1 - Standing water in more than one-half of the segment.

2 - Isolated areas of standing water, with some dry areas.

3 - Muddy or nearly dry bottom.

4 - Dry bottom, but evidence of prior submersion.

5 - Dry bottom, with no evidence of prior submersion.

The classifications of cover types and drainage ratings are subjective decisions and admittedly arbitrary. The drainage ratings are especially subject to change as weather conditions vary. They should, however, indicate gross differences in nesting conditions at the time ratings were made.

Farming Methods

All farmers living on the study areas were interviewed during the course of both summers, using techniques similar to those of McCabe (1955). Each farmer was asked his method of crop rotation (type of crops rotated and rotation sequence), type and rate of application of fertilizer and chemical sprays (herbicides and insecticides), the amount of tiling completed on his farm and the number of pheasants each thought his farm produced.

Other information was gathered by direct observation. Dates of mowing for hay, oats and diverted acres were recorded to indicate harvest chronology in relation to pheasant habitat. The amount of corn picked by the first week-end of pheasant hunting season, the amount of standing corn left over winter and total acreage plowed in the fall were recorded to indicate the effects of cover conditions on hunting success and winter populations.

Field waste

Corn (60 percent) and soybeans (25 percent) make up the majority of pheasant winter foods in central Iowa (Bolstad 1962). Since it is possible that winter food supply could thus limit pheasant populations, effort was made to determine the amounts of waste corn and soybeans on each study area after the harvest.

Three types of cornfields were sampled - those picked by hand (Amish farms), those picked with a standard cornpicker and those harvested by a picker-sheller (the latter two by modern farmers). All soybeans were harvested by a picker-sheller. The number of fields sampled was limited to those that were completely harvested and had no livestock foraging in them (Baumgras 1943). Only six corn fields (two on the Amish Area and four on the Check Area) and three soybean fields (one on the Amish Area and two on the Check Area) were available as test fields in 1968. More fields were available in 1971, but the same number were sampled to maintain continuity of sample size. Only corn fields were sampled in 1971.

The test fields were divided into plots 3 feet wide (the distance between corn rows) and 30 feet long (10 paces). The plots were established by walking 10 paces between two rows from any corner of the field and counting ears of corn or soybean pods. The investigator then moved 10 rows toward the center of the field from the end of the plot and counted in another 10-pace plot. This pattern was continued until the opposite end or side of the field was reached.

Pheasant Populations

Pheasant populations were estimated throughout the year by the use of several population indices. The distance from Ames to the study areas, however, prohibited extensive population investigations except during the summer. Research during the fall, winter and spring was limited to week-end field trips to obtain census information during critical periods in the pheasant life cycle. The limited time available and the interrupted nature of the study made it impossible to maintain exact population data throughout the course of the study. The techniques described below were used to establish indices of relative abundance for both study areas, rather than exact population counts, and their respective pheasant populations were compared on this basis.

Roadside counts

Roadside counts were made to estimate post-breeding season populations and reproductive success. A roadside count route was established approximately around the periphery of each study area to provide a continuous circuit, keep duplication of routes to a minimum and provide call count routes of approximately 10 miles in length (Fig. 6). The Amish route was 11.8 miles long and included about 3.5 miles not actually on the Amish Area, but still within the Amish colony. The Check route totalled 9.8 miles and completely enclosed the Check Area.

Counts were made in 1968 and 1971 from mid-July through August, using the technique described by Klonglan (1955b). Counts were begun in July, rather than August as suggested by Klonglan, to aid in determining chronology of the hatch. No counts were made on days it rained or days following a night of rain, excessively foggy mornings, days the wind velocity exceeded 12 mph, or on days a Duvdevani dew block registered dewfall less than one. Counts were made on all mornings exceeding these standards in 1968, but were limited to two per week in 1971, on mornings on which conditions appeared excellent.

Counts were begun at sunrise, and were made by two observers from a car driven 15 to 20 mph. The time-of-day effect was eliminated by alternating the order and direction routes were driven. No attempt was made to limit the width of the

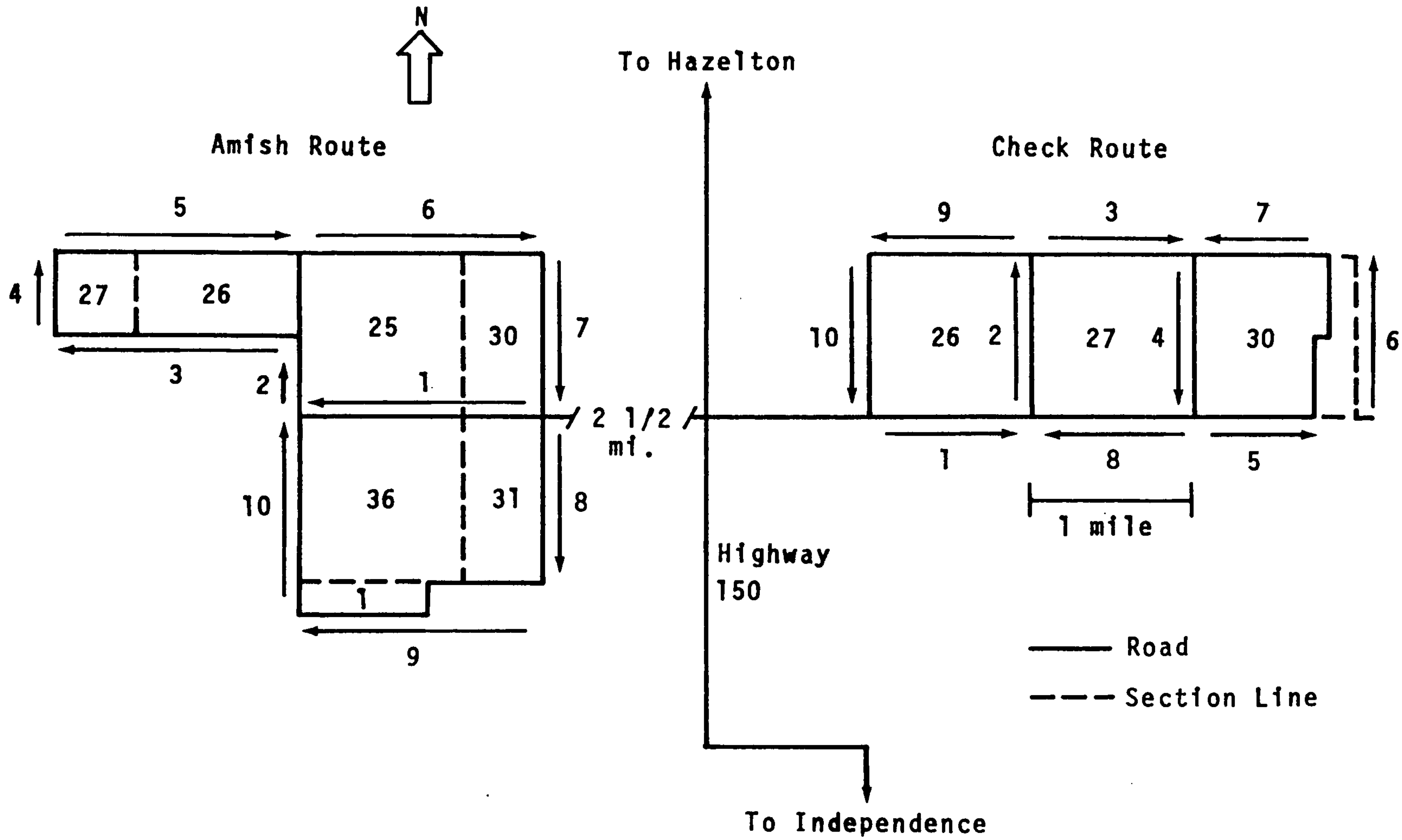


Figure 6. Location of the Buchanan County pheasant roadside and crowing-cock count routes.

area in which pheasants were seen, but sightings were recorded separately as occurring in the roadway or adjacent fields. A 7x35 mm binocular was used for counting and sexing birds, but not for locating them. Pheasants seen in the roadway were flushed to get an accurate count of the number of chicks in broods.

Each mile of both routes was assigned a number from 1 to 10. All observations on a given mile were recorded under the same number, regardless of the direction the route was driven, to allow calculation of production estimates for each mile. The number of pheasants seen, sex of adult birds, estimated ages of chicks by weeks, number of chicks per brood and exact location of all broods were recorded. The age of chicks was determined according to techniques described by Trautman (1950), and by comparison with a set of photographs of known age pheasants. Hatching dates and dates of nest initiation were computed by back-dating from the estimated age of chicks in each brood, using tables developed by Thompson and Taber (1948).

Hunter surveys

Hunters were interviewed on the opening week-end of the pheasant hunting season in 1968, 1970 and 1971, to determine hunting pressure, population estimates and age ratios of the harvested birds. In 1968, post card questionnaires were distributed to farmers who were requested to give them to hunters, or questionnaires were placed under the windsheld wipers of cars when a hunting party could not be located in the field. Both practices were discontinued after the first year due to a low rate of return, and emphasis thereafter was placed on personal interviews.

Hunters were contacted by driving along the roads around each area and noting the location of parked cars, or hunting parties, if they could be located from the road. Parties were interviewed when they returned to their cars. The study areas were small enough, and had enough interconnecting roads, to permit several trips around them while hunters were in the field. This permitted the investigator to contact most of the hunters who used the study areas, even though several parties were present at one time. Seven hours were spent on each study area during each of the week-ends involved. Saturday morning and Sunday afternoon were spent on the Check Area in 1968 and 1971, while Saturday afternoon and Sunday morning were spent on the Amish Area. The reverse order was used in 1970, to compensate for differences in hunting pressure related to the time of day or opening of the season.

Information recorded included the number of hunters, hours hunted and county of residence of each party, number and sex of all birds seen by hunters, number and age of harvested birds, cripples lost and recovered, habitat from which birds were taken and location. The age (juvenal or adult) of harvested birds was determined from bursa depth, spur length and appearance (Linduska 1943). Bursa depth was used as the determining factor when a disagreement developed between aging methods (Gates 1966).

Winter census

A winter pheasant census was conducted in 1971 and 1972, to determine post-hunting season sex ratios and estimate total populations. Counts were made on week-ends when temperatures were below 20° F., wind velocities exceeded 10 mph and snow depth was at least 6 inches (Grondahl 1952). All potential pheasant cover was searched in 1971, to familiarize the investigator with winter cover patterns and discover areas of major pheasant use. Cover types searched included farm lots, fence-rows, drainage ditches, sloughs, grassy waterways, harvested corn fields, oats and hay stubble (Green 1938). Corn and stubble fields were eliminated in 1972; only those areas which were used as cover in 1971 were searched.

The number of pheasants flushed, sex ratios and direction of flight were recorded to avoid recounting birds which flew to cover areas not yet searched. Birds for which sex could not be determined were recorded as unknowns. The amount of potential pheasant cover on each area and the location of all birds seen were plotted on cover maps to establish patterns of pheasant concentrations and winter habitat preferences. The location of pheasant tracks, and/or roosts, was recorded to indicate pheasant activity not accounted for by direct observation.

Spring crowing-cock counts

Spring crowing-cock counts were made in May 1971, to determine a spring breeding population index (Kimball 1949). Ten stops were made mid-way between intersections on the same route used for roadside counts (Fig. 6). The number of pheasant cock crowing calls heard during a 2-minute period was recorded, and separate records were kept for each stop. The exact location of each stop varied up to two-tenths of a mile where farm lots or other noise disturbances (barking dogs, etc.) were located at the half-mile point. Counts were begun one-half hour before sunrise and completed about 90 minutes later when both routes were run. The direction and order routes were driven alternated, as in roadside counts, to eliminate any time-of-day effect. No counts were made when the wind velocity exceeded 8 mph, or at any stop where a noise disturbance was considered to have biased the count (Kozicky 1952).

Information on sex ratios, harem sizes and distribution of pheasants throughout the study areas was obtained by recording the number, sex and location of all birds seen while making counts or driving between stops. No attempt was made to locate or flush pheasants, and only those readily visible from the roadway were recorded.

Mortality

Records were kept of all non-hunting mortality observed during field work or reported by farmers. Age, sex and probable cause of death were noted to indicate any differential mortality that might occur on the study areas. Predator signs were identified, where possible, using the techniques of Einarsen (1956).

Nesting Study

Intensive nest searching was conducted during the summers of 1968 and 1971, and comprised the bulk of summer research activities. All cover types which have been shown to be important pheasant nesting cover in Iowa were searched (Baskett 1947). The effort expended in each cover type, and the amount of each that was searched, depended on the amount of that cover type available, crop phenology and the harvesting methods of farmers (Stokes 1954). Approximately equal amounts of time were allotted for searching on each study area, but Amish fields were searched first if similar cover became available on both study areas at the same time.

Road ditches and waste areas were searched first because of their importance in early season nesting (Lyon 1965). Ditches were searched before and after the first mowing of hay in 1968. The second search was dropped in 1971, due to lack of time. Waste areas were searched as soon as the ditches around each section were finished. Hay, oats and diverted acres were searched after mowing. When hay mowing began before all waste areas were searched, the waste areas were finished whenever time permitted.

The total acreage of potential pheasant nesting cover on the two study areas was too large to allow a complete search of all cover types. One-half of the road ditches were sampled by searching alternate segments. Fifty percent of the waste areas were sampled by checking alternate strips approximately 8 feet wide. The investigator started at one end of each waste area and walked toward a chosen reference point on the opposite side. Most waste areas were in field corners or edges, allowing fence posts to serve as easily identifiable reference points. The 8-foot strip was obtained by searching all cover on either side of the reference line within reach of a 3-foot stick used to part vegetation. Alternate swaths the width of a mower sickle bar were searched in hay and grain fields, resulting in a 50 percent sample. In most cases, fields were not searched until the hay or straw was completely removed. When several fields were harvested at once and time became a factor, fields were searched with the crop still on the ground. No crop was removed from diverted acres fields, and all searching was done over the fallen vegetation.

Data on nesting ecology were recorded on special forms prepared by the Research Unit. Photographs of progressive embryo development were used to age embryos in incomplete clutches (Labisky and Opsahl 1958).

RESULTS

Farming methods practiced on the Amish and Check Areas are directly related to the contrasting farming philosophies. Amish farmers grow crops to feed their livestock herds. They reject modern labor-saving machinery and rely on horsepower and hard work to plant and harvest crops. Check Area farmers have abandoned large-scale livestock operations and raise crops primarily for cash sale. In so doing, they have adopted modern farming techniques and are fully automated in their field operations. These contrasting styles have created differences in farm sizes, land use patterns, the types of crops raised and crop rotations, the rates of application for fertilizers and chemical sprays and have had a marked effect on the pheasant populations residing on each study area.

Different farming methods are also used by Amish and modern farmers living on the Amish Area. In describing typical Amish Area farming methods, information obtained from modern farmers on that Area will be reported separately. Pheasant populations on the Amish Area, however, will be considered a product of the Area as a whole and not of individual farms. Amish and non-Amish data were thus combined to represent the entire Amish Area when describing the effects of Amish farming methods on pheasants. To simplify terminology, modern farmers living on the Amish Area will hereafter be referred to as non-Amish farmers, while modern farmers living on the Check Area will be called modern (or Check Area) farmers.

Land Use

Average farm size

Amish farms, with horses for power, are nearly 50 percent smaller than Check Area farms (Table 1). This is to be expected, since field work with horses takes longer than with tractors. Several Amish farmers have stated that their farms were about as large as they can operate. Amish farms on the Amish Area averaged 106 acres in 1968 and 1971, and were smaller (25 acres per farm) than the average for all Amish farms in Buchanan County in 1968 (Agribusiness Associates, Inc. 1968). They were possibly not representative of typical Amish farms, but this difference was less than the 70 acre difference between all Amish farms and modern farms, which averaged 204 acres. Non-Amish farms averaged 130 acres for the 2 years, 25 acres per farm larger than Amish farms on the Amish Area, and 70 acres smaller than modern farms on the Check Area. Since there were only five non-Amish farmers living on the Amish Area, inclusion of their lands with Amish farms had little effect on the Area-wide average, and actually brought it more in line with the over-all average for all Amish farms. The decrease in size of both Amish and non-Amish farms between 1968 and 1971 was caused by the sale of 80 acres of non-Amish land to a new Amish farmer.

Farms on the Check Area averaged 178 acres in 1968, about

Table 1. Total farm acreage, number of farms and average farm size on the Amish and Check Areas, with all farms in Buchanan County included for comparison

	Number of farms		Total acres[a]		Acres per farm	
	1968	1971	1968	1971	1968	1971
Amish Area	19	20	2187	2187	115	110
Amish farms	14	15	1487	1569	106	105
Non-Amish farms	5	5	700	618	140	124
Check Area	12	10	2019	2019	178	202
Buchanan County[b]	1740	-	348,245	-	200	-
Amish farms	129	-	16,761	-	130	-
Modern farms	1611	-	331,484	-	204	-

[a]Includes land owned by resident farmers, but not located directly on the study areas (From Agribusiness Associates, Inc. 1968).

[b]From Iowa State Department of Agriculture (1970).

20 acres smaller than other modern farms throughout Buchanan County (Table 1). By 1971, their average had increased to 202 acres. The increase was accomplished by the retirement of two farmers and the consolidation of their lands with those of neighboring farms. Information on the county-wide average was not available in 1971.

All land owned by resident farmers was included when determining average farm sizes for Amish and Check Area farms. Farm boundaries were not considered when establishing the study areas, and some farms had less than one-half of their total acreage located thereon. Farm operation was considered more important than actual land ownership for purposes of this study, and in cases where land was rented, the operator was contacted rather than the owner. When reporting specific farming methods (land use, crop rotations, fertilizer and pesticide applications), however, only those methods used directly on the study areas will be considered. Differences in farming methods were found between farmers, but individuals were consistent, and practices used on study area fields were considered representative of their entire farming operations.

Crop totals

Essentially the same crops were raised on both study areas, but differences occurred in the acreage of each crop used by Amish and modern farmers. Amish farmers relied totally on food crops for their livestock herds (Table 2). Corn, oats, pasture and hay comprised more than 85 percent of the total

Table 2. Land use on the Amish Area, 1968 and 1971

Cover type	1968		1971	
	Acres	Percentage of total	Acres	Percentage of total
Corn	814.3	39.9	753.6	36.9
Pasture	502.3	24.6	531.0	26.0
Rotation	177.4	8.7	232.7	11.4
Permanent	324.9	15.9	298.3	14.6
Oats	312.2	15.3	285.2	13.9
Hay	196.7	9.6	157.3	7.7
Farm lots	50.0	2.5	50.0	2.5
Soybeans	42.0	2.2	127.9	6.3
Ditches	37.4	1.8	37.4	1.8
Waste areas	31.1	1.5	13.6	0.7
Odd corners	2.3	0.1	1.4	0.1
Waterways	28.8	1.4	12.2	0.6
Sloughs	0.0	0.0	0.0	0.0
Diverted acres	27.5	1.3	55.2	2.7
Seeded	27.5	1.3	25.2	1.2
Fallow	0.0	0.0	30.0	1.5
Roadways and lanes	26.5	1.3	28.8	1.5
Totals	2040.0	100.0	2040.0	100.0

Area (1,724 acres in 1968 and 1,726 acres in 1971), while non-food crops (soybeans and diverted acres) averaged only 6 percent (69 acres and 183 acres, respectively). Amish farmers had no practical use for soybeans and did not utilize government land retirement programs because of religious beliefs (Gingerich 1939). All of the land used for soybeans and diverted acres was located on non-Amish farms. Check Area farmers, without large livestock herds to feed, relied more heavily on cash crops (Table 3). Corn and soybeans were planted on more than 60 percent of this Area in 1968 (1,104 acres) and 75 percent in 1971 (1,342 acres). Diverted acres, pasture, hay and oats totalled less than 30 percent (513 acres) and 14 percent (255 acres) in the same years. Although corn was the most abundant crop raised on both study areas, soybeans and pasture occupied nearly opposite positions in terms of total acreage. Six times more soybeans than pasture were planted on the Check Area in both years, while six times more pasture was found on the Amish Area. Hay and oats were less than one-half as abundant on the Check area as on the Amish Area.

A comparison with county-wide crop totals for 1968 indicates that the Check Area may not be entirely representative of land use practices throughout Buchanan County (Table 4). Corn, oats and hay percentages are roughly comparable, but three times more pasture and one-half as much soybeans (on a percentage basis) were found throughout the county. This is

Table 3. Land use on the Check Area, 1968 and 1971

Cover type	1968		1971	
	Acres	Percentage of total	Acres	Percentage of total
Corn	659.8	37.2	929.6	52.3
Soybeans	445.1	25.1	413.2	23.3
Diverted acres	184.5	10.4	76.4	4.3
Seeded	120.2	6.8	32.0	1.8
Fallow	64.3	3.6	44.4	2.5
Oats	145.1	8.2	101.6	5.7
Pasture	116.2	6.6	27.0	1.5
Rotation	48.0	2.7	7.3	0.4
Permanent	68.2	3.9	19.7	1.1
Hay	68.1	3.8	51.8	2.9
Waste areas	67.3	3.7	86.8	4.9
Odd corners	29.2	1.6	31.0	1.7
Waterways	19.9	1.1	15.9	0.9
Sloughs	18.2	1.0	39.9	2.2
Ditches	37.0	2.1	36.6	2.1
Farm lots	31.8	1.8	31.8	1.8
Roadways and lanes	21.1	1.1	21.1	1.1
Total	1776.0	100.0	1776.0	100.0

Table 4. Land use in Buchanan County, Iowa, for comparison with the Amish and Check Areas (Iowa Department of Agriculture 1970)

Cover type	Acres	Percentage of total
Corn	118,769	34.1
Pasture	64,442	18.5
Soybeans	46,691	13.4
Hay	29,772	8.5
Oats	23,945	6.9
Other	64,626	18.6
Total	348,245	100.0

probably indicative of the relative importance still attached to the dairy industry in eastern Iowa. Check Area farmers, however, have largely abandoned livestock operations and require less pasture. Only three farmers still maintained milking herds in 1971, and none pastured beef cattle. Most livestock consisted of hogs and poultry. All farmers on the Amish Area still had dairy herds, and Amish farmers maintained horse herds for field operations and transportation.

Marked differences also appeared in the utilization of uncultivated land. Cultivated lands comprised 87 and 91 percent of the Check Area in 1968 and 1971, respectively, or about 10 percent more than on the Amish Area (77 and 79 percent in the same years). Buchanan County was only 63 percent cultivated in 1968, or nearly 25 percent less than the Check Area (Iowa State Department of Agriculture 1970). Most of the uncultivated land on the Amish Area was in permanent pasture

(70 percent) with small acreages in farm lots, ditches, roadways, lanes and waste areas (Table 5). Waste areas made up the largest portion of the uncultivated lands on the Check Area (30 percent in 1968 and 40 percent in 1971), while permanent pasture was less abundant (30 percent and 10 percent). Farm lots and lanes occupied less total acreage on this Area because of the larger farms and smaller livestock herds found there.

Table 5. Use of uncultivated land on the Amish and Check Areas, 1968 and 1971

	1968		1971	
Cover type	Acres	Percentage	Acres	Percentage
	Amish Area			
Permanent pasture	324.9	69.1	298.3	69.7
Farm lots	50.0	10.6	50.0	11.7
Road ditches	37.4	8.1	37.4	8.7
Waste	31.1	6.6	13.6	3.2
Roadways and lanes	26.5	15.6	28.8	6.7
Total	469.9	100.0	428.1	100.0
	Check Area			
Permanent pasture	68.2	30.2	19.7	10.0
Farm lots	31.8	14.1	31.8	16.2
Road ditches	37.0	16.4	36.6	18.7
Waste	67.3	29.9	86.8	44.3
Roadways and lanes	21.1	9.4	21.1	10.8
Total	225.4	100.0	196.0	100.0

Trends in land use changes

Changes in land use between 1968 and 1971 indicated a trend toward greater use of row crops on both areas, with a loss of hay and small grains (Fig. 7). A 40 percent increase

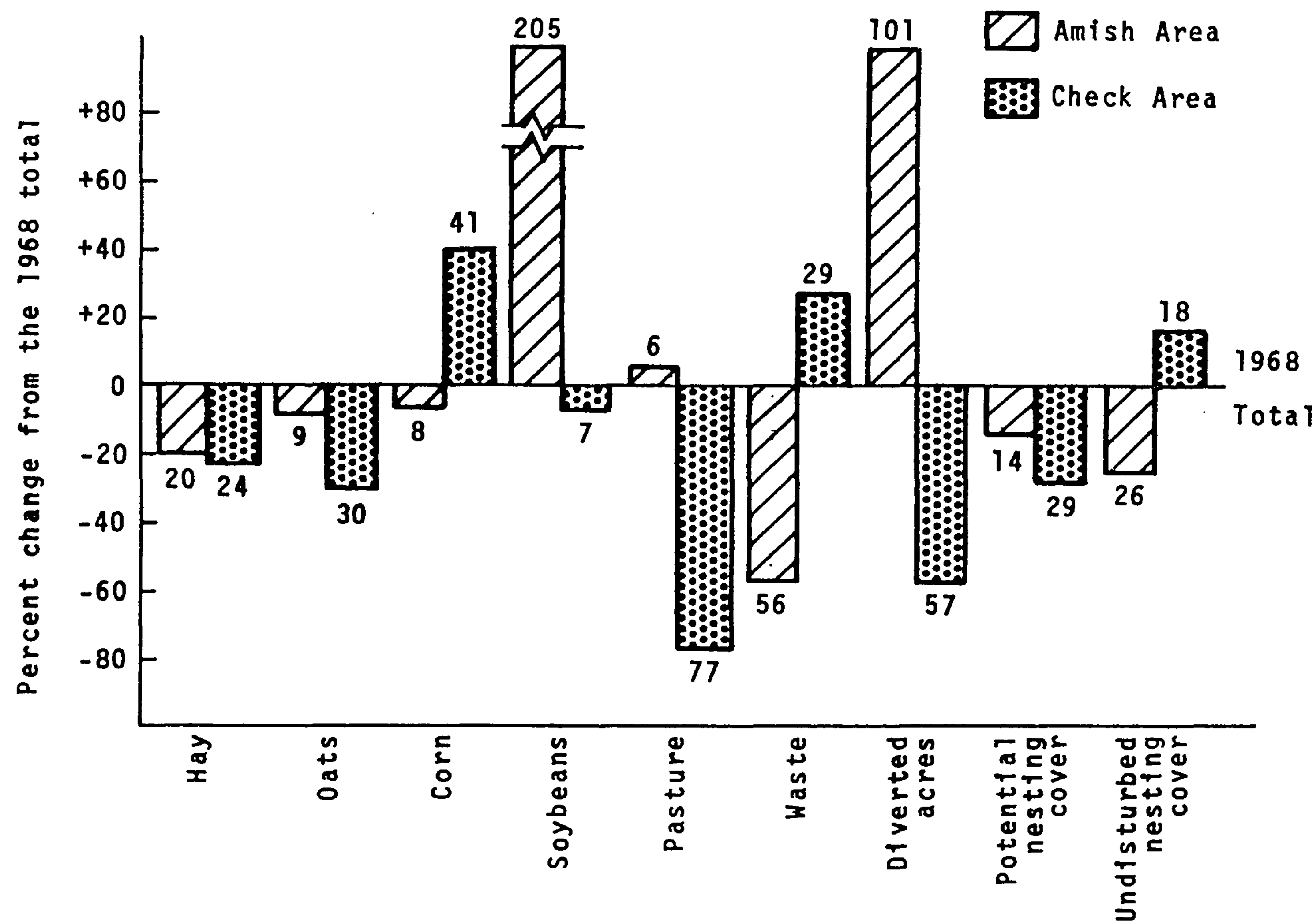


Figure 7. Change in land use on the Amish and Check Areas from 1968 to 1971, with differences listed as the percent change in 1971 from the 1968 total.

(270 acres) in corn acreage and a 57 percent decrease (108 acres) in diverted acres were the biggest changes on the Check Area in terms of total acreage, and were attributed to a liberalizing of restrictions in the federal feed grain program. Farmers were allowed to plant more corn than in past years and still retain their diverted acres subsidies. Consequently, several fields previously in land retirement programs or other crops were switched to corn. The biggest percentage loss occurred in pasture (77 percent), although the total acreage involved (89 acres) was small, compared to the increase in corn acreage. This loss, and the 54 percent decrease in hay and oats, resulted from a decline in the number of farmers having dairy cattle. A net gain of 30 percent in waste areas occurred when a 28-acre pastured slough was allowed to return to its natural, semi-wet condition, even though another slough was partially drained.

Increases of 205 percent in soybeans and 101 percent in diverted acres on the Amish Area represented changes on non-Amish farms, only. Actual acreage increases were smaller, and diverted acres still constituted less than 3 percent (55 acres) of the total Area in 1971 (Table 2). The 88-acre increase in soybeans was more substantial, however, and corresponded to a loss in hay and oats acreage on non-Amish farms. The loss of hay and oats on Amish farms was smaller (10 acres), and was offset by a gain in rotational pasture. This was not considered a major trend in Amish land use, but merely a normal occurrence in the crop rotation cycle of Amish farmers. The 56 percent decrease in waste, involving only 18 acres, was caused by the drainage of the last remaining wet area and its conversion to a straight-line drainage ditch.

Field sizes and fencerows

Smaller fields and 2 1/2 times as many miles of fencerows (excluding road ditch fences) were found on the Amish Area, due to the presence of Amish livestock herds. The use of 100 percent more forage crops (hay, oats and pasture) by Amish farmers created a more diverse land use pattern than existed on the Check Area. Combined with the smaller average size of Amish farms, this resulted in Amish fields averaging 16 acres for 1968 and 1971, or about 50 percent smaller than Check Area fields (Table 6). Thirty-four miles of fencerows (measured from aerial photos) were needed to keep Amish livestock confined to pastured areas, while Check Area farmers used their 14 miles of fencerows mainly to separate neighboring farms. Non-Amish farmers also had larger fields (averaging 25 acres) than Amish farmers, but their dairy herds prevented elimination of all fences.

Although the presence of more fences on the Amish Area created more areas of potential pheasant cover, only 1 mile (3 percent) was considered to contain sufficient vegetation to shelter pheasants (Table 6). Judgment of cover quality was based on an arbitrary estimation of the cover characteristics

Table 6. Comparison of field sizes and miles of fencerows on the Amish and Check Areas, 1968 and 1971

	Amish Area				Check Area	
	Amish		Non-Amish			
	1968	1971	1968	1971	1968	1971
Average field size (acres)	16	15	23	27	29	35
Miles of fencerows	-	34	-	14	-	14
With vegetation	-	1	-	1	-	8
Without vegetation	-	33	-	13	-	6

of these fencerows, including vegetation density and height, and sightings of pheasants or pheasant sign. Grazing of livestock, and weed removal by Amish farmers to create a neater farm appearance, were the primary causes for the lack of fencerow cover. Several Amish farmers were observed cutting weeds with hoes or scythes, but none used chemical herbicides for this purpose. Other farmers, and all of the Check Area farmers, were not seen weeding their fencerows. The Check Area had only 14 miles of fences, but 8 miles (56 percent) were overgrown enough to provide some cover for game.

Pheasant nesting cover

Pheasant nesting cover on the two study areas consisted of two major types. Potential pheasant nesting cover existed in hay fields, oat fields, diverted acres, waste areas and road ditches. Undisturbed nesting cover, which was not mowed during the summer, was found in waste areas (waterways, sloughs, odd corners) and road ditches.

More potential pheasant nesting cover existed on the Amish Area in both years, but Amish farming practices severely reduced the quality of this cover for pheasant use. Potential nesting cover averaged 28 percent (560 acres) of the Amish Area for 1968 and 1971, compared to 21 percent (370 acres) of the Check Area (Fig. 8). Most of the Amish Area nesting cover consisted of hay, oats and seeded diverted acres (27 percent of the entire Area), however, which are favorite pheasant nesting habitats, but produce high mortality rates for hens and chicks when mowing occurs (Wagner et al. 1965). Permanent, undisturbed cover, in which nesting success may be high (Lyon 1965), comprised only 3 percent of the Amish Area. This type of cover was found in road ditches (2 percent of the Area) and waste areas (1 percent). Most of the waste areas were in the form of grassy waterways and drainageways (Table 2), and portions of both were considered too wet for nesting. Amish farmers turned livestock into these areas following the harvest of adjacent fields, and the vegetation was either trampled or grazed close to the ground. This rendered them nearly worthless for pheasant cover and left little residual vegetation for the following spring.

Undisturbed cover was found on 6 percent (124 acres) of the Check Area, even though total potential nesting cover was less abundant (Fig. 7). Undisturbed cover was found in odd corners, sloughs and grassy waterways. Vegetation in these areas consisted of giant ragweed, goldenrod, various grasses

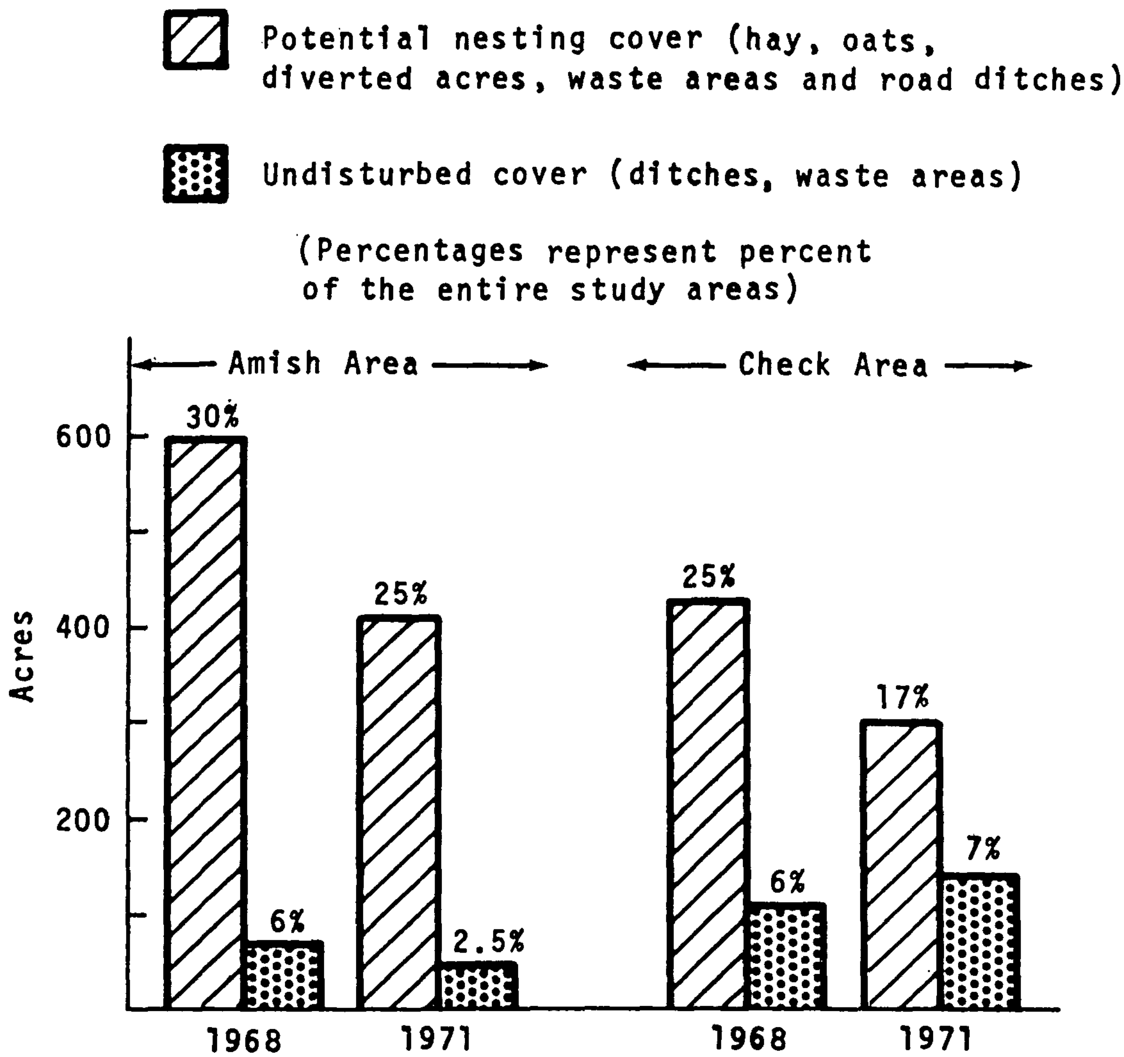


Figure 8. Potential and undisturbed pheasant nesting cover on the Amish and Check Areas, 1968 and 1971.

(bluegrass spp., brome spp., reed canary grass, slough grass and several others) and other herbaceous vegetation. Portions of these areas were dry and appeared to offer excellent nesting cover. None of these areas were grazed during the study, but were potential pastures if Check Area farmers would have had livestock.

Total potential nesting cover decreased by 14 percent on the Amish Area and 29 percent on the Check Area between 1968 and 1971 (Fig. 7), mainly due to the decline in hay and oats acreage on non-Amish and modern farms. The 26 percent decrease in undisturbed cover on the Amish Area resulted from the draining of wet areas, while the 18 percent increase on the Check Area was caused by the reversion of a pasture to waste (as explained above).

<u>Pheasant winter cover</u>

More than three times as much pheasant winter cover was found on the Check Area in both 1971 and 1972 (Fig. 9). Waste areas composed the majority of winter cover on the Check Area (75 percent), with eight farm shelter belts, unmowed diverted acres and one exceptionally weedy road ditch contributing to a total of 105 acres, 6 percent of the entire Area. Other road ditches around both Areas, and harvested corn fields, tended to drift over with snow early in the winter and lost their effectiveness as pheasant cover. No wooded areas existed on either Area, other than in farmstead lots.

Suitable winter cover occupied only 2 percent (40 acres)

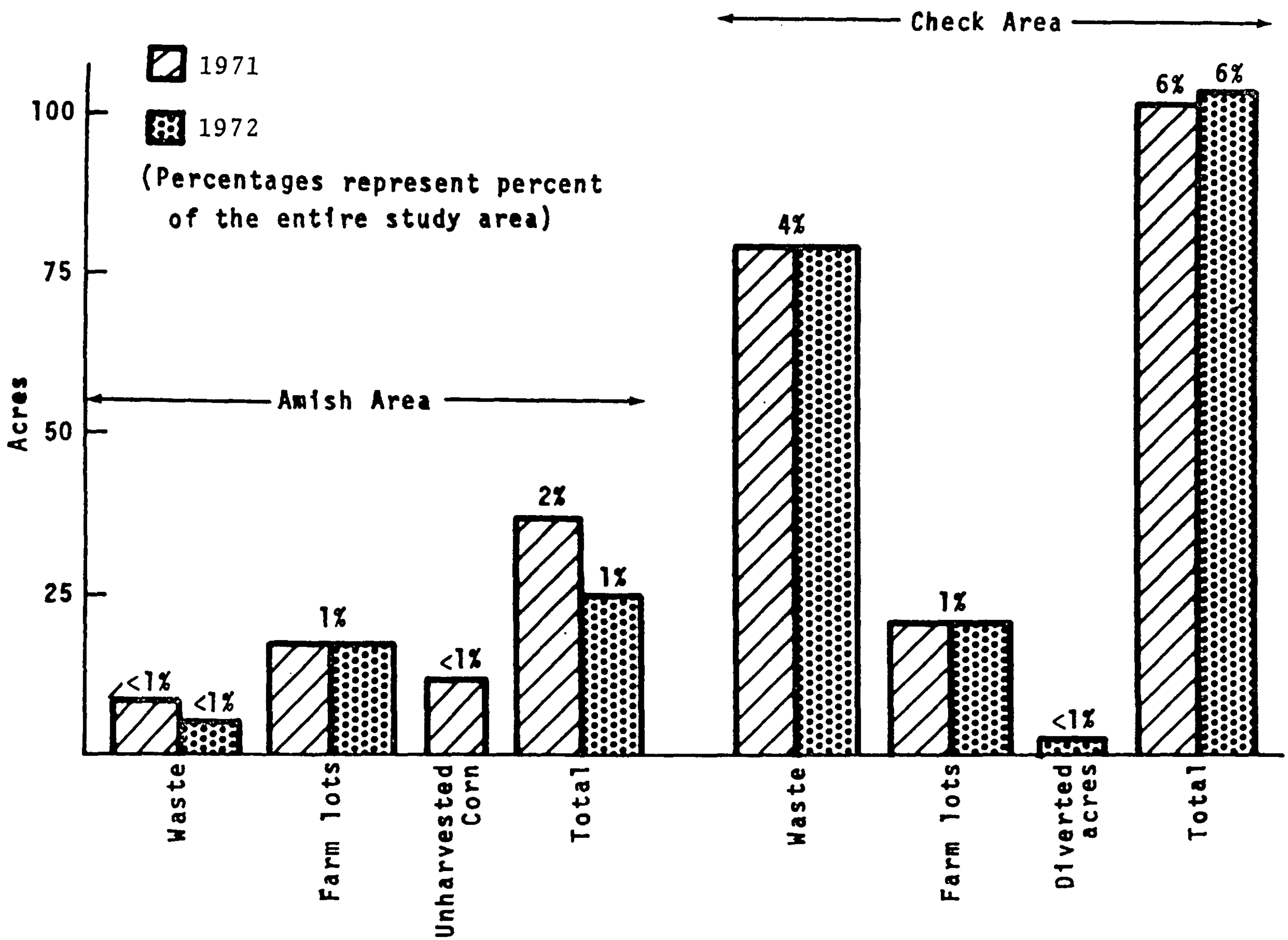


Figure 9. Potential winter cover on the Amish and Check Areas, 1971 and 1972.

of the Amish Area, and its effectiveness was reduced by grazing activities. In addition to grazing waste areas, most Amish farmers used farm shelter belts as holding pens for carriage and work horses. The understory vegetation was grazed or trampled in most cases, and all pheasant ground cover was removed. Unharvested corn fields provided both food and cover for pheasants, but only one such field was found in 1971, none in 1972. One grazed drainage ditch provided shelter from wind and blowing snow, even though little vegetation was present. Fencerows provided additional winter cover on both areas, but the effects of grazing and weed removal, and the number of suitable fencerows present on each area were discussed above.

Cover type distribution

Cover maps indicated that the distribution of potential pheasant cover on the Amish Area was primarily related to the crop rotation practices of Amish farmers (Fig. 10 and Fig. 11). The location of hay and oat fields, which made up the majority of nesting cover, varied from year to year as crops were rotated, but they were distributed throughout the Area. Waste areas changed size due to drainage activities, but their locations were determined by topographic features (generally waterways) and remained stable. The best winter cover (farm lots and waste areas) was mostly in permanent cover areas which did not change location. Corn fields moved according to crop rotation patterns, but the small corn acreage in suitable cover rendered them less important to pheasants.

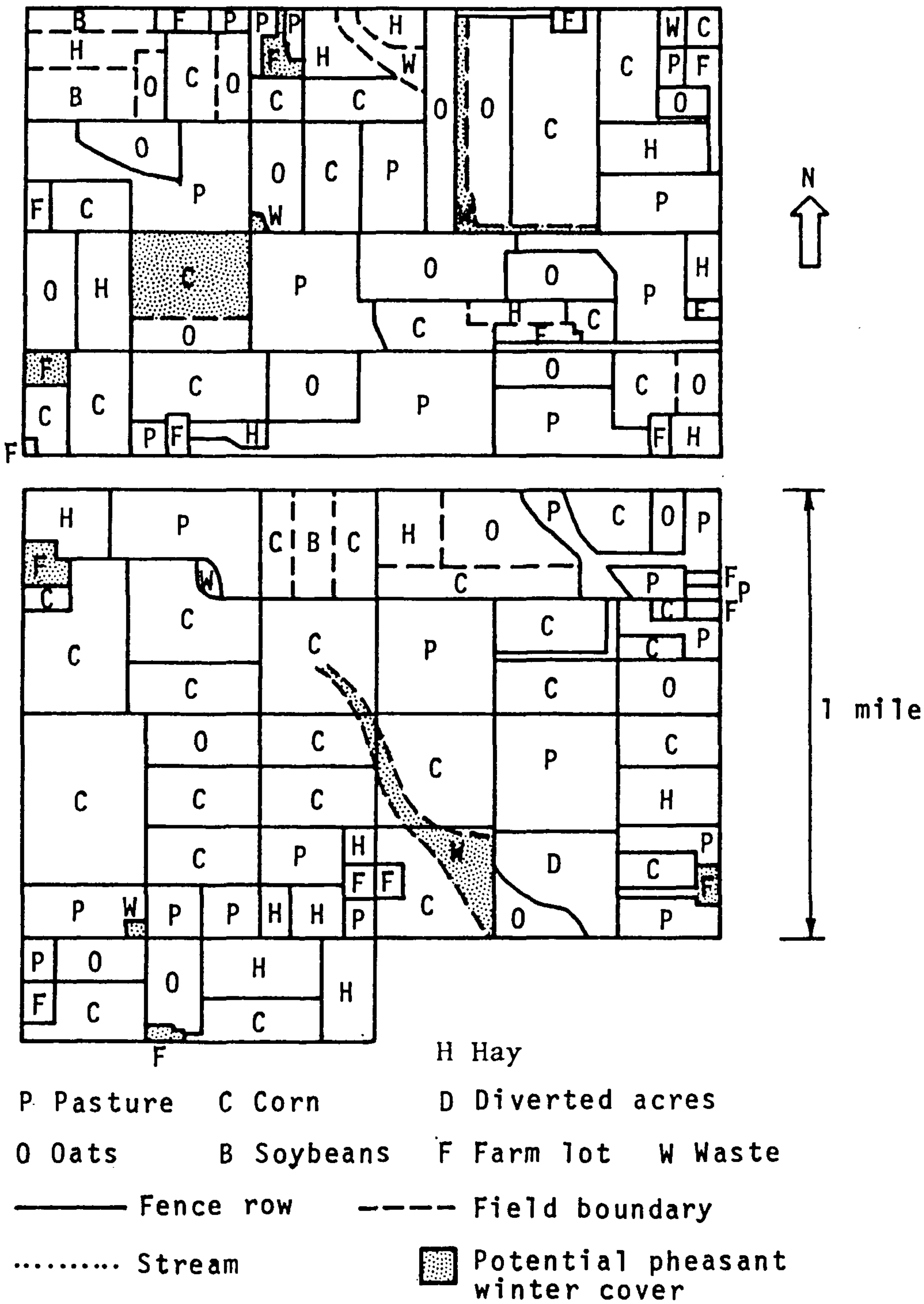
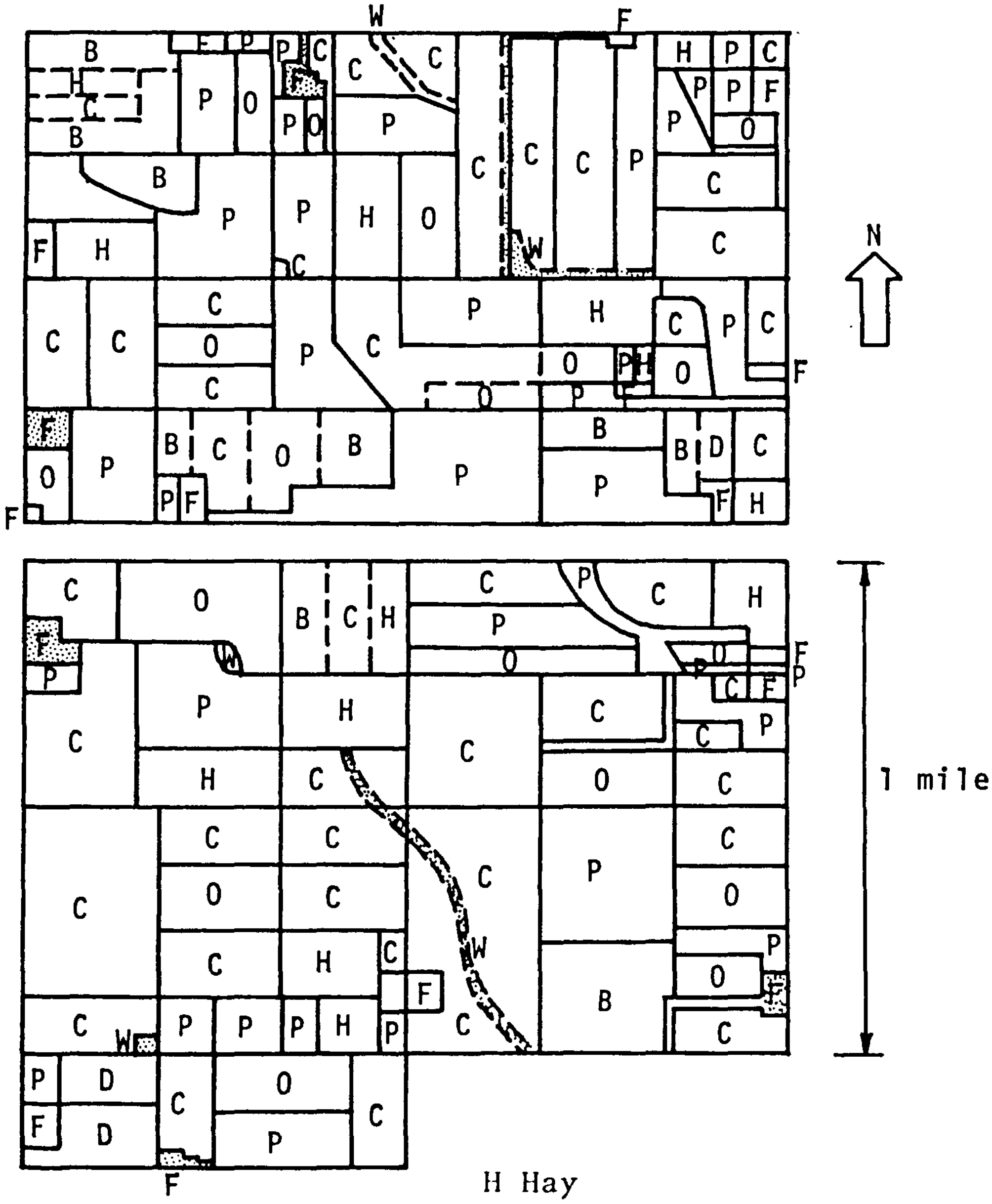


Figure 10. Cover map of the Amish Area, 1968, with special reference to winter pheasant cover.



H Hay

P Pasture C Corn D Diverted acres

O Oats B Soybeans F Farm lot W Waste

——— Fence row – – – Field boundary

········ Stream ▒ Potential pheasant winter cover

Figure 11. Cover map of the Amish Area, 1971, with special reference to winter pheasant cover.

Check Area cover maps (Fig. 12 and Fig. 13) revealed that pheasant cover on this Area varied little in location from year to year. Hay, oats and corn fields shifted somewhat, but not in a regular pattern like Amish fields. Since most potential cover was in undisturbed areas, locations for both nesting and winter shelter cover remained relatively stable throughout the study.

Farming Methods

Crop rotations

Amish farmers have continued to use traditional crop rotation practices, while most modern farmers have switched to continuous cropping methods (Table 7). A 3-year rotation of corn, oats and hay was used by 50 percent of all Amish Area farmers (9 farmers in 1968 and 10 in 1971). Five Amish farmers used rotations of 4 years duration (corn, oats, hay and pasture) and three used a 5-year rotation (corn, corn, oats, hay and pasture). Of the five non-Amish farmers, three used a 3-year cycle and two had changed to continuous corn and soybeans. Three Check Area farmers still rotated their crops in 1968, but only one continued to do so in 1971, the loss occurring when two farmers retired in the interim. All of the modern farmers who rotated crops had dairy herds and needed hay and oats for forage. Two farmers with dairy herds had previously switched to continuous corn and purchased the necessary feed from their neighbors. Eight Check Area farmers continued to raise some hay and oats in 1968, or utilized government land

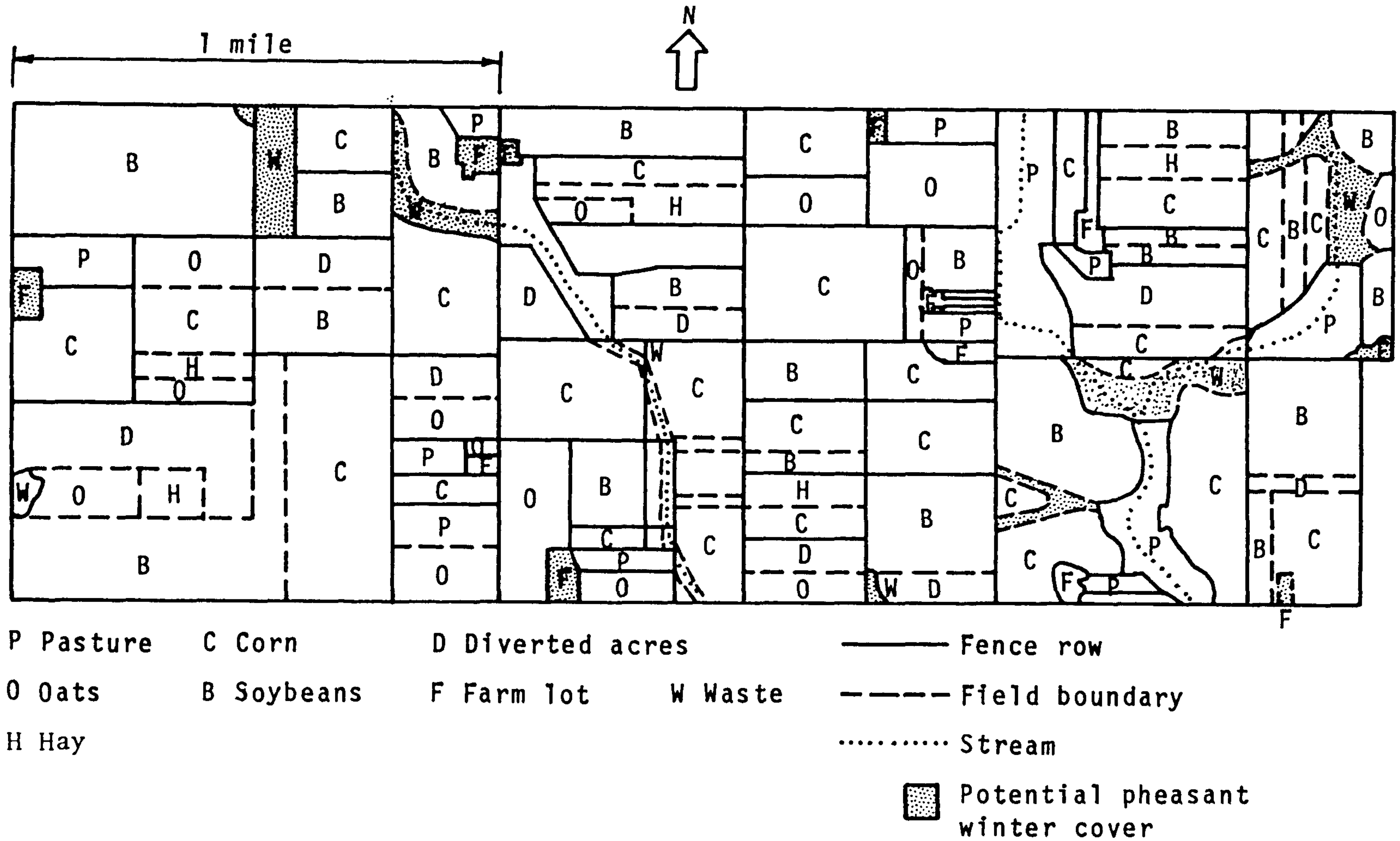


Figure 12. Cover map of the Check Area, 1968, with special reference to winter pheasant cover.

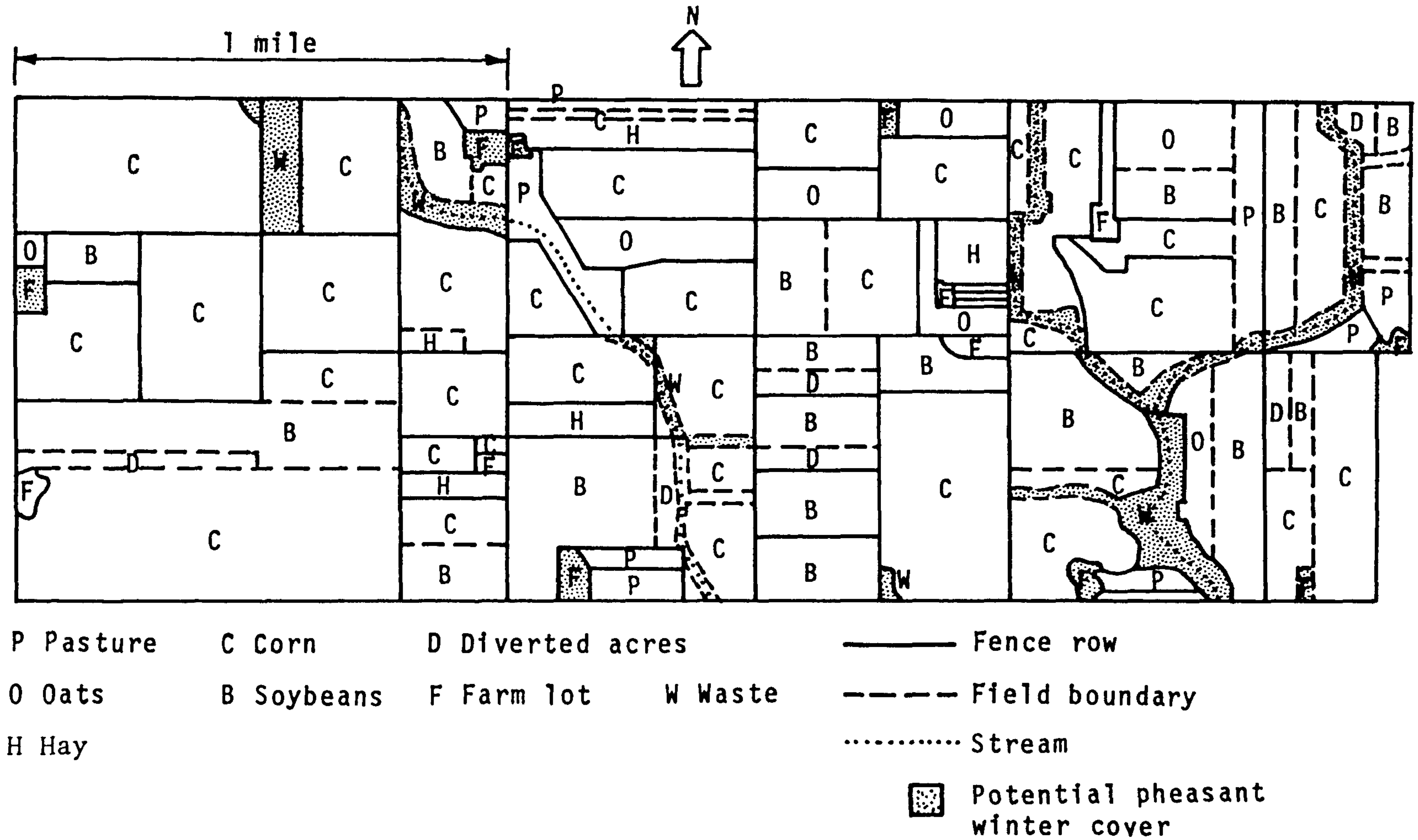


Figure 13. Cover map of the Check Area, 1971, with special reference to winter pheasant cover.

Table 7. Crop rotation practices of Amish and modern farmers on the Buchanan County pheasant research areas, 1968 and 1971

Number of years per cycle	Amish Area 1968	Amish Area 1971	Check Area 1968	Check Area 1971
0	2[a]	2[a]	9	9
3	9[b]	10[b]	2	1
4	5	5	1	0
5	3	3	0	0

[a]Non-Amish farmers.

[b]Includes two non-Amish farmers.

retirement programs to some extent, but these crops were planted as needed, rather than in a specific crop rotation cycle. By 1971, only four farmers still planted these crops.

The regular rotations used by Amish farmers contributed to the loss of pheasant cover on that Area. All fields were subjected to grazing at least once every 5 years, and most once in 3 years. Each fencerow was grazed approximately twice as often (once from either side), which prevented vegetation, other than annual grasses, from establishing permanent stands. Livestock, especially horses, were often observed leaning across fences and eating grass from the opposite side, thereby eliminating cover in the entire fencerow.

Fertilizer applications

The use of regular crop rotations and animal manure allowed Amish farmers to maintain soil fertility with less commercial fertilizer than was used by Check Area farmers (Table

8). Agronomists long ago established the beneficial effects of regular crop rotations and manure on soil fertility and texture (Thompson 1957). All Amish farmers made use of the manure produced by their livestock herds by spreading it on their fields. Manure was not spread at any particular time of year. Spreading was done in both spring and fall, and one farmer did so whenever he had the opportunity. Most spreading was done on oat fields after the harvest, on hay and rotation pasture prior to plowing for corn and on permanent pasture. Although all five non-Amish farmers had access to manure for fertilizer, only three took time to spread any on the study area fields during the study.

The only Check Area farmers observed spreading manure were the three maintaining dairy herds. The others had small amounts of hog or chicken manure available, but spread it less frequently than Amish farmers.

Nine Amish farmers (over 60 percent) applied 100 lb. of starter fertilizer per acre, while eight Check Area farmers (75 percent) used 200 lb. or more (Table 8). Several analyses were used by various farmers, but 6-24-24 (lb. of N, P and K per 100 lb. of fertilizer) was the most common, being used by 14 Amish farmers and 10 Check Area farmers. Starter fertilizer was applied to corn and soybeans during planting as an initial boost to the crop. Check Area farmers followed the starter with applications of anhydrous ammonia to corn, but none of the Amish farmers used this nitrogen supplement. Eighty

Table 8. Fertilizer use and application rates for commercial fertilizers used by Amish and Check Area farmers, 1968 and 1971

Fertilizer type	Rate of application (lbs./acre)	Number of farmers: Amish Area, Amish 1968	Amish 1971	Non-Amish 1968	Non-Amish 1971	Check Area 1968	Check Area 1971
Manure	Unknown	14	15	3	3	4	3
Starter fertilizer	100	9	9	1	0	-	-
	125	2	2	-	-	1	0
	150	1	3	1	2	1	1
	175	-	-	-	-	2	1
	200	-	-	3	3	4	4
	225	-	-	-	-	2	2
	250	-	-	-	-	-	-
	275	-	-	-	-	1	0
	300	-	-	-	-	1	2
Anhydrous ammonia	100	-	-	-	-	5	2
	125	-	-	-	-	3	3
	150	-	-	-	-	4	3
	175	-	-	-	-	0	1
	200	-	-	1	1	0	1

percent of the Check Area farmers applied 100-150 lb. of ammonia per acre in both 1968 and 1971. Non-Amish farmers used applications of starter similar to Check Area farmers, but only one used anhydrous ammonia.

More than twice as much starter fertilizer was applied to the Check Area in both study years, but the average application per acre was only 60 percent greater (Fig. 14). Check Area applications totalled 104 tons in 1968 and 140 tons in 1971, averaging 195 and 215 lb. per acre, respectively. Amish Area applications totalled 50 and 55 tons, averaging 132 lb. per acre for both years. The difference in total applications was attributable to the heavier application rates used by Check Area farmers (Table 8) and the greater corn and soybean acreage found on this Area (Table 2 and Table 3).

Amish farmers applied about 50 percent less starter per acre (100 lb.) than either non-Amish or Check Area farmers, and Amish application rates changed little between 1968 and 1971 (Fig. 14). Average Check Area rates increased by 10 percent during the same period, but this was caused by a redistribution of corn acreage to farmers using heavier application rates, rather than a general increase in rates among farmers (Table 8). Thus, the 36-ton increase in total applications of starter on the Check Area resulted from the increase in corn acreage, and not from a trend to greater per-acre use of fertilizer.

Only 8 tons of anhydrous ammonia were applied to the Amish

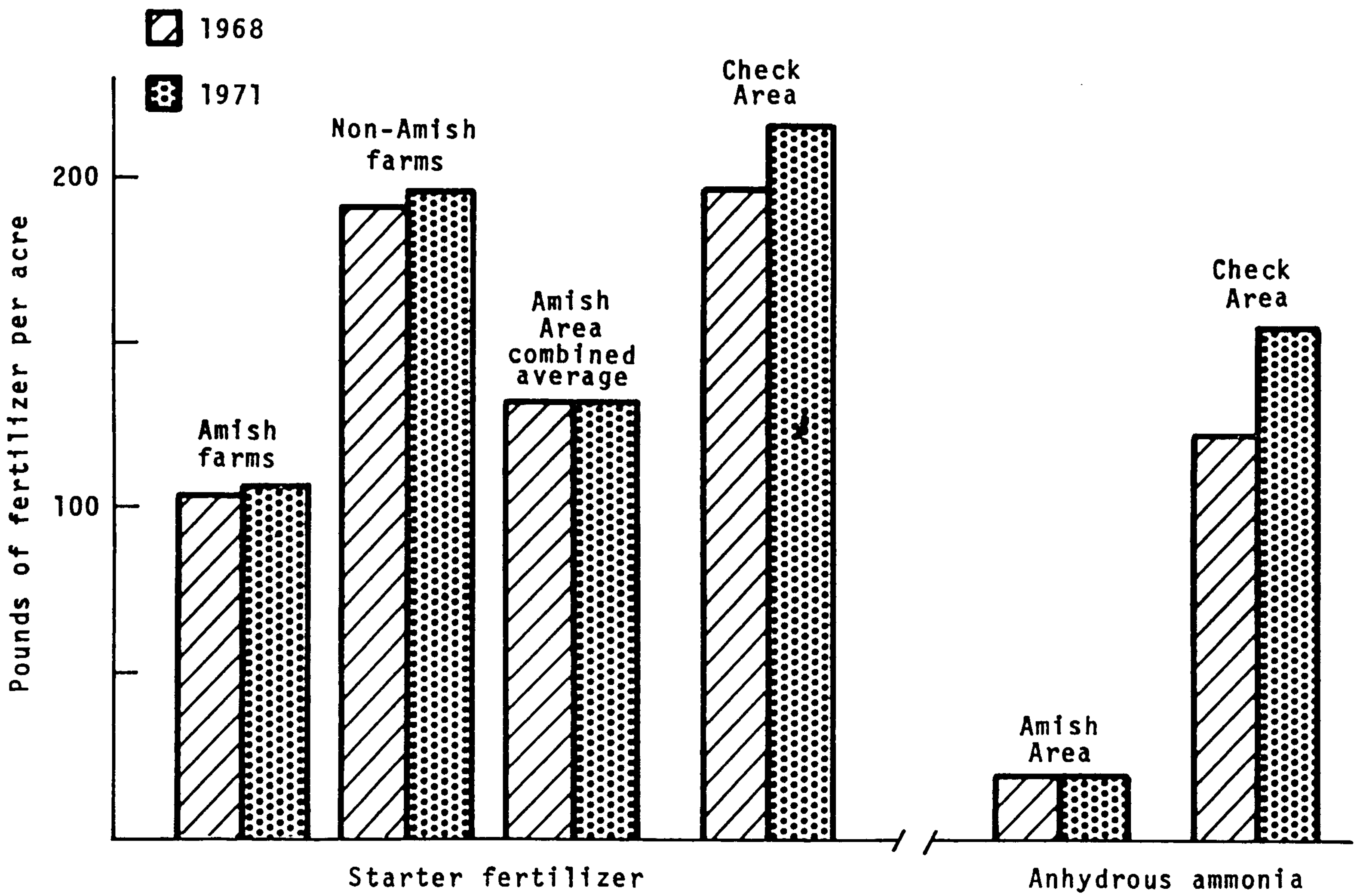


Figure 14. Average application rates (lb. per acre) for commercial fertilizers used on the Amish and Check Areas, 1968 and 1971.

Area in each year (averaging 20 lb. per acre), compared to 42 tons applied to the Check Area in 1968 (120 lb. per acre) and 70 tons in 1971 (155 lb. per acre).

Average application rates for anhydrous ammonia on the Check Area increased for the same reasons the rates for starter increased. The total and average applications of ammonia for the Amish Area represent use on one (non-Amish) farm only, and do not present an accurate picture of anhydrous ammonia applications throughout the Area. Ammonia was applied to one 58-acre corn field (2 percent of the Amish Area) in both years, and any possible effects resulting from its application were considered unimportant to the Area as a whole.

Chemical pesticide applications

All farmers on both study areas reported using chemical herbicides on corn and soybeans, but Amish farmers tended to use less than either non-Amish or Check Area farmers (Table 9). Atrazine was the most popular herbicide used on corn. All but one (non-Amish) farmer on the Amish Area, and one-half of the Check Area farmers, used it in one of several forms or applications. Treflan was used by two-thirds of the non-Amish and Check Area farmers planting soybeans, possibly because the low application rates (1 lb. per acre) meant reduced costs. All of the herbicides listed in Table 9 were used to control annual grassy or broadleaved weeds, all were described by Thomson (1964) as non-injurious to wildlife and the reported application rates were within the safety limits established by

Table 9. Rates of application for chemical herbicides used by Amish and Check Area farmers, 1968 and 1971

			Number of farmers					
			Amish Area					
		Application	Amish		Non-Amish		Check Area	
Crop	Herbicide	rate	1968	1971	1968	1971	1968	1971
Corn	Atrazene	1 lb./acre	1	1	-	-	-	-
		2 lbs./acre	7	7	-	-	-	-
		3 lbs./acre	2	4	1	1	7	5
		4 lbs./acre	1	1	2	2	-	-
		4 1/2 lbs./acre	-	-	1	1	-	-
	Atrazene + oil	2 lbs./acre	2	2	-	-	1	1
	Atrazene + Sutan	2 lbs./acre	-	-	-	-	1	2
	Amiben	2 lbs./acre	-	-	-	-	2	2
	2,4-D	2 lbs./acre	-	-	-	-	1	0
		3 lbs./acre	-	-	1	1	-	-
Soybeans	Treflan	1 lb./acre	-	-	3	3	6	6
	Amiben	1 lb./acre	-	-	-	-	1	0
		3 lbs./acre	-	-	-	-	3	2
	Randox	1 1/2 lbs./acre	-	-	-	-	2	2

Thomson. They were applied at various stages of the crop cycle (pre-plant, pre- and post-emergence) depending on their mode of action, and at rates related to their method of application (broadcast or banded). A more complete description of each herbicide is listed in Appendix III. Check Area farmers also reported using Preforan, Vernam, Lasso, Ramrod and several other herbicides in the past, depending on the nature of the weeds they wanted to control. All of these fall into the same category as the herbicides listed in Table 9 and will not be considered further, since most farmers did not remember the specific application rates or acreages involved. In the following discussion, all herbicides will be considered together, since they were used for essentially the same purpose and had similar effects.

Total applications of herbicides followed a pattern similar to fertilizer use, but similar average application rates were used on both study areas (Fig. 15). About 2,000 lb. of herbicide were applied to each area in 1968, averaging 2.5 lb. per acre on the Amish Area and 2.4 lb. per acre on the Check Area. Applications decreased to 1,900 lb. (2.1 lb. per acre) on the Amish Area in 1971, but increased to 2,800 lb. (2.5 lb. per acre) on the Check Area. As in total applications of fertilizer, changes in the total acreage planted to corn and soybeans and a redistribution of these crops to farmers using heavier application rates were more important in causing the increase on the Check Area than per-acre changes in herbicide

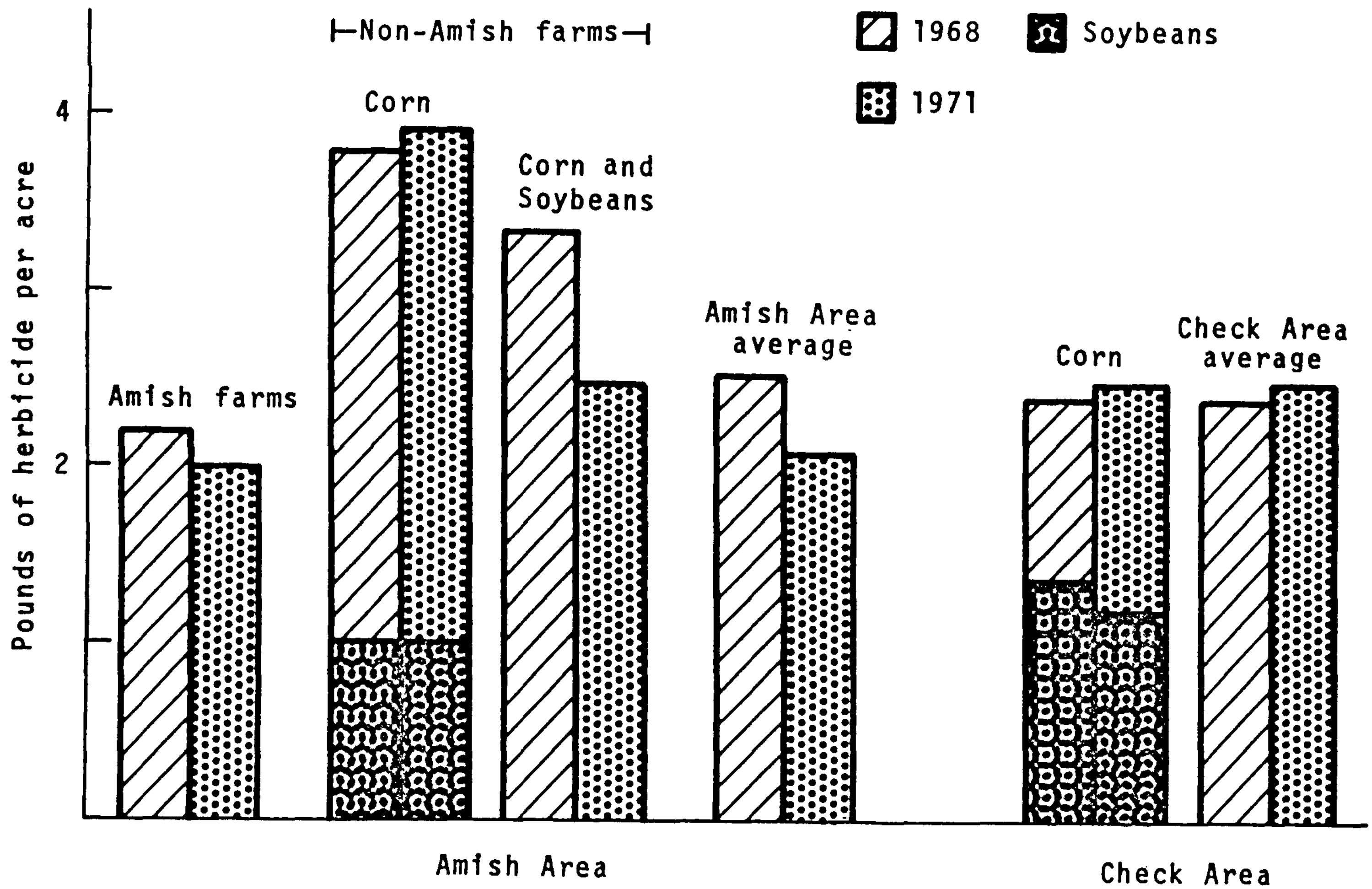


Figure 15. Average application rates (lb. per acre) for chemical herbicides used on corn and soybeans on the Amish and Check Areas, 1968 and 1971.

use. The decrease in average application rates on the Amish Area resulted from the increase in soybean acreage on non-Amish farms. Herbicide applications to soybeans averaged only 1 lb. per acre, less than one-half the rate applied to corn, thereby decreasing the average for both crops.

Check Area farmers applied slightly more herbicide per acre than Amish farmers, averaging 0.3 lb. per acre more for both years. Non-Amish farmers, however, applied at least 1 lb. per acre more than either Amish or Check Area farmers, thus raising the average rate applied to Amish Area fields to about the same level used on the Check Area.

In addition to herbicides used on corn, Amish farmers reported their use on oats or pasture when weeds became a problem. They were used selectively to kill individual plants, however, and definite application rates could not be determined.

Only one insecticide was used on either area. In 1971, two Check Area farmers reported the use of Dyfonate, an organophosphate, to kill corn rootworms on a selective basis. Dyfonate was applied to 198 acres of corn at 2 lb. per acre, for a total application of 396 lb. Several other Check Area farmers reported using Dyfonate, or other insecticides, in the past as needed, but no Amish farmers reported such a use. Corn rootworms are seldom a problem when crops are rotated, but tend to appear when a corn monoculture develops (Thompson 1957). Dyfonate is considered potentially dangerous to wildlife and lethal for birds (Thomson 1970).

None of the Amish Area farmers reported past use of the common insecticides harmful to wildlife (DDT, aldrin, dieldrin, heptachlor, etc.). Several Check Area farmers reported using some of these in the past, especially DDT, but none had used any in the past 6 years.

Harvest results

Different harvesting methods were used by Amish and modern farmers, but they apparently had little effect on harvest chronology or pheasant cover under normal weather conditions. Amish farmers put up hay loose and threshed oats, using horse-drawn mowers and binders for cutting. They husked corn by hand and often chopped and shocked the remaining stalks for fodder or bedding. Modern farmers baled hay and combined oats using conventional tractor-drawn equipment. Corn was picked with a standard picker or a self-propelled picker-sheller, with the remaining stalks left broken down in the field.

Harvest chronology for hay and oats, 1968. Different harvesting methods affected the mowing of hay and oats in 1968, but weather patterns throughout the summer were probably more important in determining harvest chronology (See Description of the Study Areas - Weather, p. 24). The acreage of hay and oats mowed each day throughout the summer is listed in Appendixes IV and V. The first mowing of hay began at essentially the same time on the Amish and Check Areas, but progressed more rapidly on Amish farms (Fig. 16). The light rain that fell throughout the summer delayed mowing in all fields and ruined much of the crop after it was cut. Several fields on both areas were never completely harvested, and no farmers had begun a second mowing by September 1st. To prevent undue field spoilage, Amish and modern farmers cut only a few swaths around a field at once and picked up hay as soon as possible, which made it difficult to estimate the exact amount cut at a given time. The acreages listed in Appendixes IV and V indicate the day on which fields were first mowed, regardless of the extent of mowing, in an attempt to determine what the harvest chronology might have been had the weather not been a major factor. Observations in 1971 indicated that this may have biased the data for Amish farms more than Check Area farms. Modern farmers tended to mow each field completely and could usually remove the hay in one day, after it had cured. Amish farmers, however, often mowed less than a whole field at one time, especially fields larger than 10 acres, since it took longer to pick up hay with horse-drawn equipment. Thus, the 7-day lag between the time 50 percent of all hay fields were harvested (the 50 percent loss level) on Amish and modern farms was probably exaggerated for this year. The 50 percent loss level was arbitrarily chosen as a potentially important indicator of pheasant nesting success in relation to crop phenology. If broods could be brought off in 50 percent of the hay fields prior to the first mowing of hay, it was felt that a good

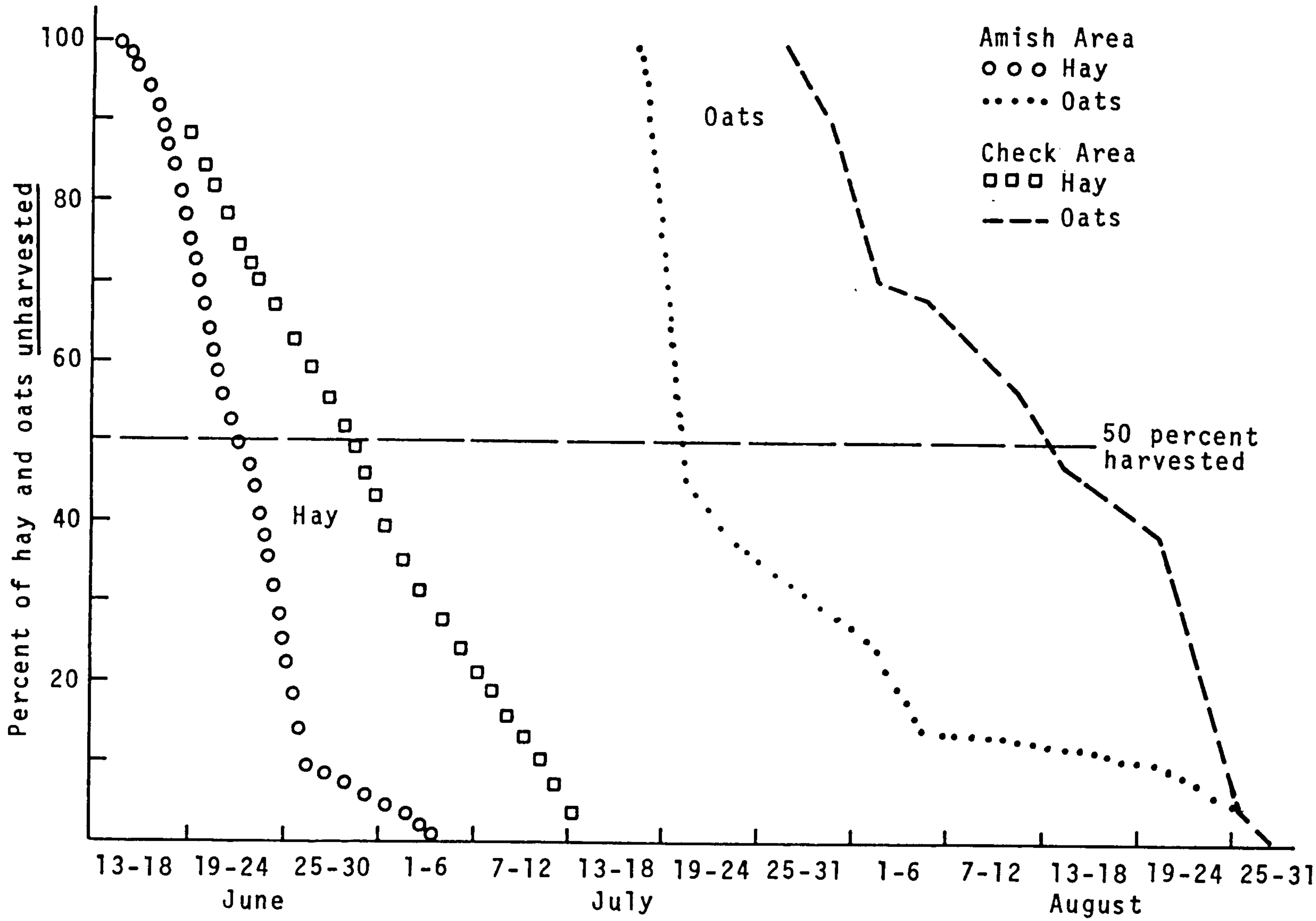


Figure 16. Chronological reduction of available nesting cover resulting from the harvest of hay and oats, 1968.

start would be made on a successful nesting season (assuming a random distribution of nests among hay fields).

A greater difference was seen in small grain harvesting, due to the threshing activities of Amish farmers. The Amish mowed oats in mid-July and left the grain in shocks in the field for 2 - 3 weeks to cure. Check Area farmers allowed grain to mature on the stalk and harvested it when fully ripe later in July and August. Operations of both types of farmers were delayed by the severe rain storm which occurred on July 17th. The Amish were about 50 percent finished with mowing, but heavy rain destroyed many shocks of grain and further rain showers delayed mowing for 2 - 3 weeks. None of the modern farmers had begun harvesting before the storm, and much of the standing grain was destroyed by lodging or by rain knocking grain from the stalk. This delayed harvesting until the end of August. Non-Amish farmers faced the same problem as modern farmers, and most of the grain harvesting late in August on the Amish Area occurred on their farms.

These chronologies indicate that more late-season nesting cover existed on the Check Area in 1968, especially in oat fields, and that nests established in Check Area fields had a greater chance of remaining undisturbed by harvesting operations until hatching than nests on the Amish Area.

Harvest chronology for hay and oats, 1971. Smaller differences appeared in harvest chronologies in 1971, due to more favorable weather conditions. Less rain in early June allowed the first mowing of hay to begin one week earlier than in 1968, and haying was completed on both areas by July 13th (Fig. 17). The 50 percent loss level occurred on the same date (June 21st) on Amish and modern farms.

Grain harvesting began a week earlier on Amish farms than in 1968 and was nearly completed in one week (Fig. 17). Non-Amish and Check Area farmers began harvesting more than a week later than Amish farmers, but also finished without delay. The 50 percent loss level for oats occurred one week earlier on the Amish Area than on the Check Area (July 16th and July 23rd, respectively), indicating that similar cover conditions existed on both Areas.

The 50 percent loss level for hay occurred on the same day (June 21st) on the Amish Area in 1968 and 1971, but occurred one week earlier (June 21st compared to June 28th) on the Check Area in 1971. The same loss level for oats occurred only 3 days earlier (July 16th compared to July 19th) on the Amish Area in 1971, but was found 3 weeks earlier (July 24th compared to August 15th) on the Check Area. The mowing dates recorded in 1968 represented the date of initial mowing, however, and not the date mowing was completed. The actual date the 50 percent loss level was reached on both areas in 1968 was estimated to be considerably later than in 1971 for both hay and oats. Since precipitation totals for June and July were much closer to normal than in 1968 (Fig. 5, p. 25), it is believed that the harvest chronology for 1971 was more nearly

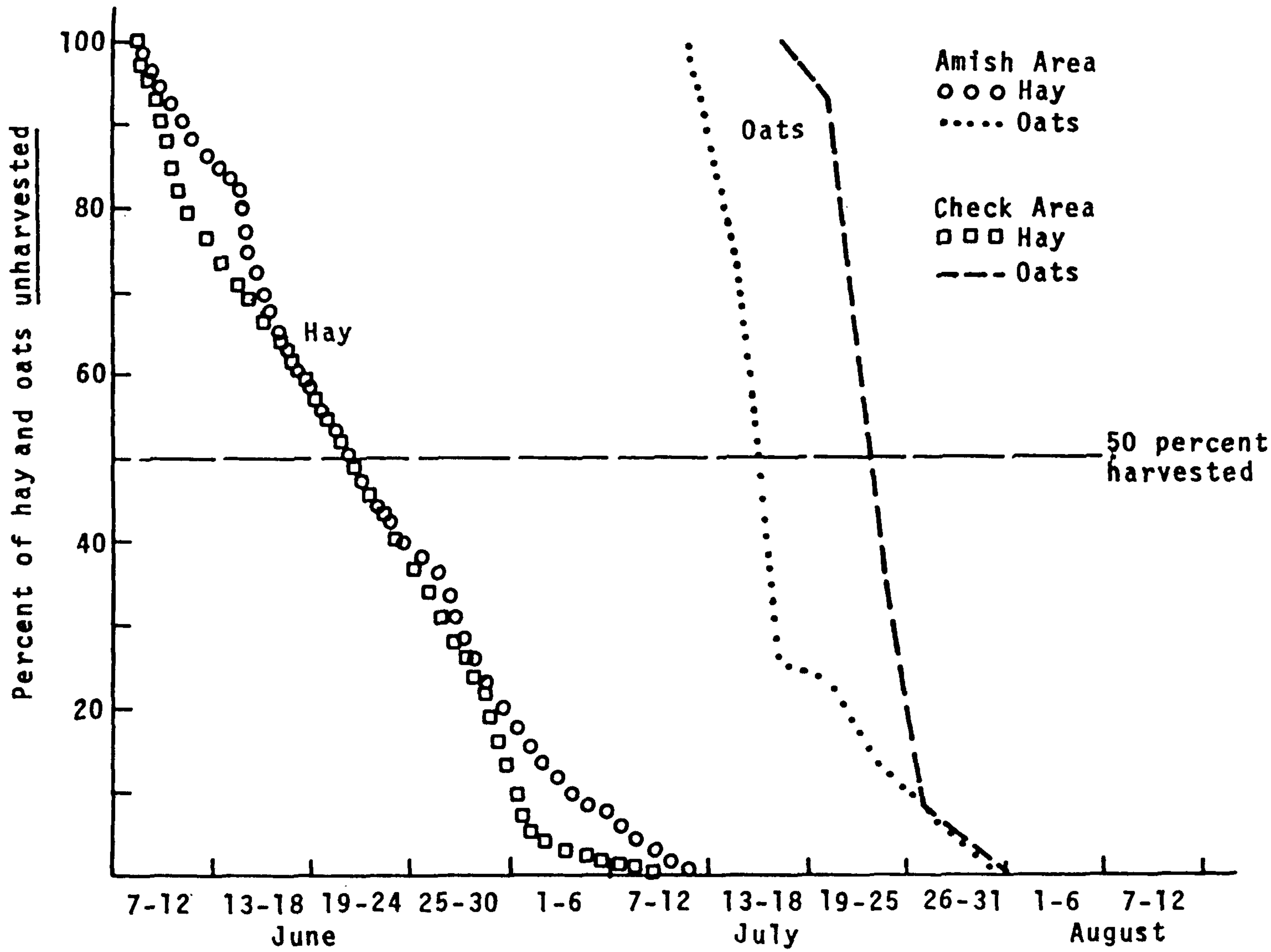


Figure 17. Chronological reduction of available nesting cover resulting from the harvest of hay and oats, 1971.

typical.

These harvest chronologies do not consider supplemental nesting cover in diverted acres, waste areas and road ditches. Lack of these cover types on the Amish Area made the loss of hay and oats more damaging to pheasant cover, and 90 percent of all nesting cover was disturbed during the hay and oats harvest (Fig. 8, p. 56). Only 76 and 59 percent of this cover was disturbed on the Check Area in these years, mostly because of the presence of waste areas. Diverted acres were more prominent on the Check Area, but some of these fields were mowed occasionally and thereby lost as cover. Diverted acres were not included in the harvest chronologies because farmers often mowed only the weedy areas of these fields, while others did not mow them at all. This made it difficult to estimate acreages that were mowed or establish a pattern of mowing.

Corn harvest. Under normal weather conditions, corn harvesting appeared to progress at the same rate on Amish and modern farms (Table 10). In 1968, less than 50 percent of the corn on either area was harvested by the first week-end of pheasant hunting season (November 11th). The extremely rainy summer and fall created muddy soil conditions and prevented farmers from moving equipment into the fields. Modern farmers, with their heavy machinery, were handicapped most and had harvested only 163 acres (25 percent of their corn acreage), or 38 percent less corn than Amish farmers, who used only a wagon and team of horses. With normal weather in 1971, both

Table 10. Total corn harvest by the first week-end of pheasant hunting season, November 11, 1968 and November 13, 1971

	1968		1971	
	Acres	Percentage of corn acreage	Acres	Percentage of corn acreage
Amish Area	303.3	40.6	618.7	82.1
Check Area	162.7	24.7	643.2	85.4
Statewide[a]	-	53.0	-	78.0

[a]From U.S. Department of Agriculture (1968 and 1971).

types of formers were able to complete 80 percent of their harvest by November 13th. Weekly corn harvest totals for all of Iowa revealed that 53 percent of the crop was harvested by the same week-end in 1968, compared to 78 percent in 1971 (U.S. Department of Agriculture 1968 and 1971). This indicated that Amish and Check Area farmers did not change harvesting methods between years, but were affected mainly by weather conditions.

Field waste. More waste corn was left in the Check Area fields than on the Amish Area in both 1968 and 1971, indicating that husking by hand is more efficient than mechanical picking. Only five ears of corn were found while searching sample plots in two Amish fields in 1968 (37 ears per acre), compared to 113 ears (339 ears per acre) found on four Check Area fields (Table 11). Ears-per-acre totals were computed by expanding the number of ears found in all sample plots (90-square feet each) to include one acre. In 1971,

Table 11. The amount of waste corn left in harvested fields on the Amish Area (husked by hand) and the Check Area (harvested with tractor-mounted pickers or a picker-sheller)

	Total no. plots		Total ears		Ears per acre	
	1968	1971	1968	1971	1968	1971
Amish Area	65	61	5	15	37	119
Check Area						
Tractor-mounted picker	81	78	69	70	414	434
Picker-sheller	83	76	44	45	255	288
Combined harvesting methods	164	154	113	115	339	357

15 ears (119 ears per acre) were found in Amish fields, compared to 115 ears (357 ears per acre) in Check Area fields. Thus, nearly 10 times more potential pheasant food was left in Check Area fields in 1968, and 3 times more was left in 1971.

Over 50 percent more waste was found in Check Area fields harvested with tractor-mounted equipment than in fields where a self-propelled picker-sheller was used (Table 11), indicating that newer harvesting methods may reduce field waste available to wildlife.

Foraging livestock further reduced the amount of waste corn available to wildlife on the Amish Area. Amish and non-Amish farmers turned horses, cattle and hogs into harvested corn fields to clean up waste corn, but only two Check Area farmers did so in either year.

Wet fields in 1968 probably accounted for the 300 percent increase in waste corn found in Amish fields in 1971, while Check Area waste remained nearly the same. Amish farmers were unable to harvest most fields by the time sampling was accomplished in 1968, and spent more time in each field than in 1971, when more fields were available. Check Area farmers were unaffected by the delay, since mechanical pickers were unable to pick corn missed on the first pass through a field.

Sampling soybean fields for bean pods and corn fields for kernels of corn proved too time consuming to be practical, and was not completed in either year. Finding soybean pods in sample plots was no indication of the number of beans available in that plot, since many broken, empty pods were found where no individual beans existed. Other plots contained many beans but no pods. Since the same harvesting methods were used for soybeans on both Areas, the greater soybean acreage found on the Check Area was believed to indicate a greater abundance of potential wildlife food existed on that Area. Random scattering of kernels, and the presence of corn cobs without kernels attached, were also found on the Check Area, probably due to the grinding action of mechanical pickers, but were rare on the Amish Area.

Fall plowing

Only 10 percent (193 acres) and 5 percent (110 acres) of the Amish Area was plowed in the fall in 1968 and 1971, respectively, compared to 15 percent (275 acres) and 31 percent (542 acres) on the Check Area (Table 12a). The total acreage fall-plowed on the Check Area thus exceeded the Amish Area total by 41 percent in 1968 and 400 percent in 1971. Hay, rotation pasture, corn and soybeans were the crops most commonly plowed under in the fall, and the greater acreage of corn and soybeans on the Check Area probably accounted for the greater incidence of fall plowing there. Amish farmers, however, used these fields for fall pasture and did not plow them until spring. The difference in the amount of fall plowing between years was apparently caused by the wet field conditions existing in 1968. Since most corn fields were not harvested prior to freezing, they could not be plowed, and most of the plowing was done in hay and pasture. No apparent explanation was found for the decrease in fall plowing on the Amish Area. More fields were harvested and available for plowing in 1971, but most Amish farmers did not plow at all that year. Eighty-five of the 110 plowed acres were located on non-Amish farms.

Table 12a. Total acreage plowed in the fall on the Amish and Check Areas, 1968 and 1971

	1968		1971	
	Acres	Percentage of total Area	Acres	Percentage of total Area
Amish Area	193	9.5	110	5.4
Check Area	275	15.4	542	30.6

Pheasant Populations

Pheasant censuses used to indicate relative pheasant abundance on the Amish and Check Areas revealed that: 1) Very small pheasant populations existed on both study areas in 1968, 2) Amish Area populations remained small or decreased by 1971 and 3) Check Area populations increased considerably during the same period. A rain of cloudburst proportions (10 inches in 24 hours) and subsequent flooding in 1968 probably decimated populations on both areas, therefore population levels found in 1971 are believed to be more nearly typical.

Roadside counts

Thirteen roadside counts (totaling 156 miles on the Amish route and 130 miles on the Check route) were made on each route in 1968, and eight counts (96 miles on the Amish route and 80 miles on the Check route) were secured in 1971. Several other counts secured in 1968 were inaccurate because rain showers or dense fog conditions developed after the counts were begun. One count was discarded in 1971 because strong winds and threatening rain clouds developed during the count.

Comparing the number of birds seen per mile driven revealed that similar small populations existed on both Areas in 1968, but about 195 times more birds were seen per mile on the Check route in 1971 (Table 12b). Considering only birds observed in the road right-of-way, 0.06 birds were seen per mile on the Amish route in 1968 (5 cocks and 5 hens), compared

Table 12b. Number of pheasants observed per mile on the Amish and Check routes, 1968 and 1971, considering only pheasants sighted in the road right-of-way

	Amish route[a]		Check route[b]	
	1968	1971	1968	1971
Hens per mile	0.03	0.0	0.07	0.3
Cocks per mile	0.03	0.02	0.08	0.13
Chicks per mile	0.0	0.0	0.0	3.5
Total pheasants per mile	0.06	0.02	0.15	3.9

[a]A total of 156 miles was driven in 1968 and 130 miles in 1971.

[b]A total of 130 miles was driven in 1968 and 80 miles in 1971.

to 0.15 birds per mile on the Check route (11 cocks and 9 9 hens). This difference was not statistically significant (t = 1.55 P < 0.1). In 1971, 0.02 birds were seen per mile on the Amish route (2 cocks) and 3.9 were seen on the Check route (10 cocks, 24 hens, 277 young). Only those pheasants seen in the road right-of-way were considered, since apparent differences in land use and harvest chronologies found on the study areas may have affected the visibility of pheasants located in adjacent fields (Klonglan 1955b).

Comparing routes between years indicated that the number of pheasants sighted remained relatively stable on the Amish route, but increased substantially on the Check route (Table 12b). The decrease from 0.06 to 0.02 birds per mile on the Amish route was not statistically significant (t = 1.67 P < 0.1), while a 26 - fold increase occurred on the Check route (from 0.15 to 3.9 birds per mile). The number of cocks observed per mile on the Amish route changed little between years, and the decrease in total birds per mile was caused by the absence of sight records of hens on the 1971 counts. Small increases were observed in both hens and cocks per mile on the Check route, but the major portion of the total increase was contributed by an increase from 0 to 3.5 young per mile.

Comparison of mean dewfall readings for the 2 years revealed that dewfall can not be regarded as responsible for the changes in numbers of birds counted. Dewfall averaged 6b (Duvdevani units) in 1968 and 4a (Duvdevani units) in 1971, indicating that dewfall was heavier during the 1968 counts. Thus, more pheasants ought to have been seen in that year, if similar populations existed. Furthermore, no significant correlation was found between dewfall and the number of birds sighted for either route in either year, suggesting that this factor was not operative under existing local conditions.

Minimum population estimates obtained from the greatest number of pheasants seen on one roadside count followed a pattern similar to birds-per-mile averages. The greatest total number of pheasants seen on one count in 1968 was three, found on each of the routes. Only one pheasant was seen on each of two counts on the Amish route in 1971, but daily totals for the Check route were 21, 15, 21, 31, 55, 84, and 59 birds. The average total number of pheasants observed per count was 0.8 and 0.2 for the Amish route in 1968 and 1971, respectively, compared to 1.5 and 41.9 for the Check route. These data indicate that many more birds were found on a modern farming area in 1971 than were found on Amish farms.

Broods and production. Roadside count data indicate that few pheasants were produced on either study area in 1968, or on the Amish Area in 1971. No broods were observed during roadside counts on the Amish Area in either year, and all five hens accounted for were seen in 1968. All 9 hens seen on the Check route in 1968 were broodless, but 19 of 24 hens (79 percent) observed in 1971 had broods. A comparison of brood sizes, locations and estimated ages indicated that 17 broods, observed 39 times, showed a total of 142 young (Table 13). Broods averaged 8.4 young at the time of their largest sighting (any observation when all chicks were thought flushed) and 6.2 young on their latest sighting, a loss of about 2 chicks per brood throughout the summer. Largest brood sightings made after the chicks were 8 weeks old were not considered, since mobility between broods increases after that age (Errington and Hamerstrom 1937).

Brood sightings made during other field activities indicated that some pheasant reproduction occurred that was not accounted for by roadside counts. Six broods (40 chicks) were observed on the Check Area in 1968 prior to the beginning of roadside counts (Table 13). The latest observation was made prior to the storm on July 17th, however, and no chicks were seen after that date. Broods were not observed during other

Table 13. Average brood size observed on the Amish and Check Areas, 1968 and 1971

	Amish Area 1968	Amish Area 1971	Check Area[a] 1968	Check Area[a] 1971
Number of broods	0	0	6	17
Number of chicks				
Largest sighting[b]	-	-	40	142
Last sighting	-	-	30	106
Average brood size				
Largest sighting[b]	-	-	6.7	8.4
Last sighting	-	-	5.0	6.2

[a]Data from 1968 represent brood sightings made during other field work. Data from 1971 represent brood sightings made during roadside counts.

[b]Data represent the greatest number of chicks ever seen in each individual brood prior to their 8th week of age.

field activities on this Area in 1971. One brood (12 chicks) was reported by an Amish farmer in 1971, but could not be re-located for verification. No other broods were observed on the Amish Area, nor were any reported by farmers.

Hatching chronologies were established for the Check Area in 1968 and 1971 by back-dating from the estimated age of all broods observed. Too few broods were observed in both cases to permit any definite conclusions, but the chronologies will be used to indicate trends, since no other information is available.

The peak of the limited hatch apparently occurred in early June in 1968, compared to early July in 1971 (Fig. 18). Three of six broods observed in 1968 had hatched by June 5th, with

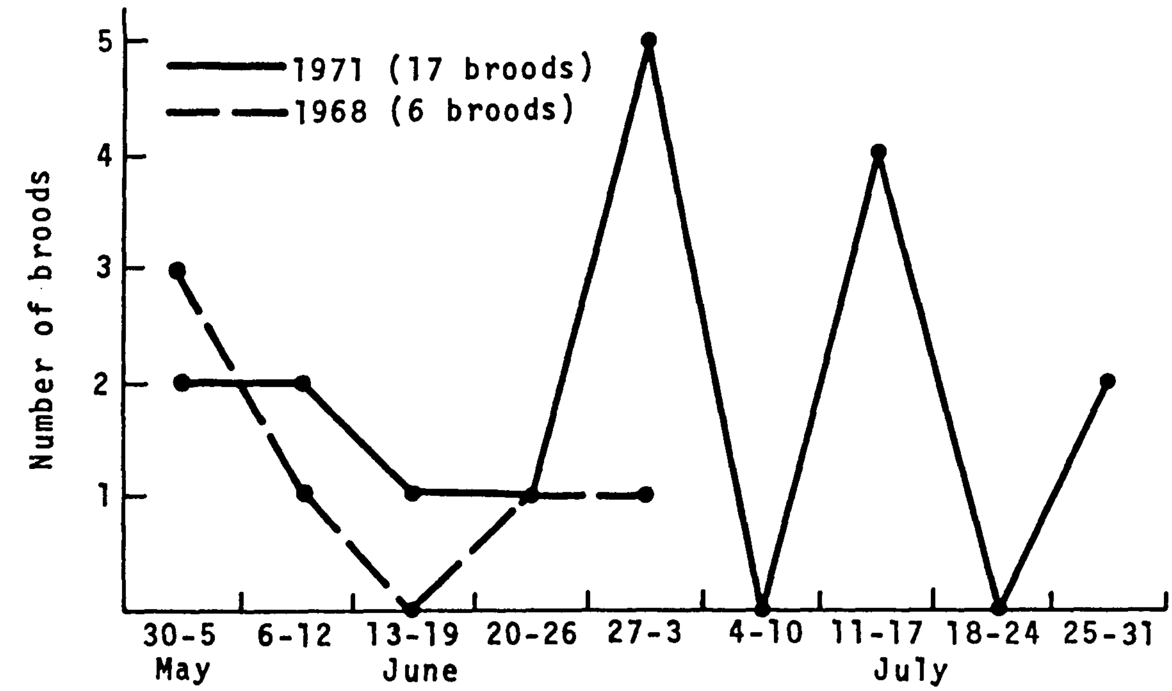


Figure 18. Hatching chronology for the Check Area, 1968 and 1971 (from brood sightings).

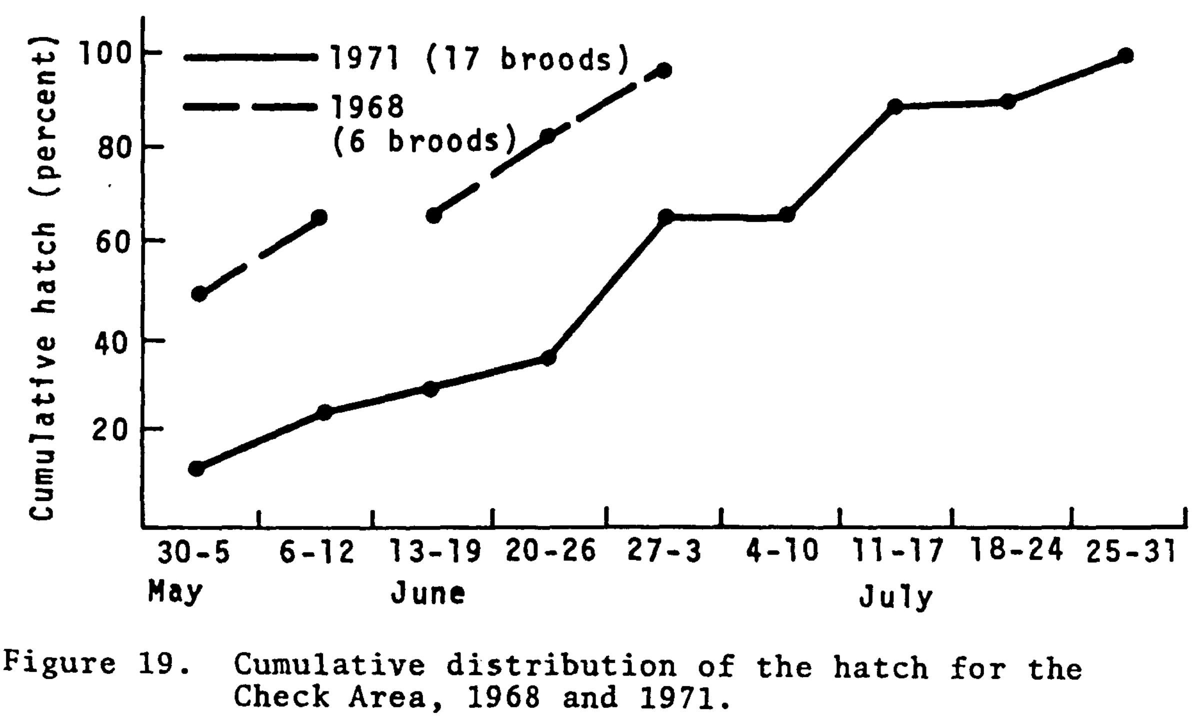


Figure 19. Cumulative distribution of the hatch for the Check Area, 1968 and 1971.

the remaining 3 distributed over a 4-week period ending July 3rd. The earliest broods observed in 1971 also had hatched by June 5th, but 9 broods (53 percent) hatched during a 3-week period from June 27th to July 17th. Errors in estimating the ages of some broods probably account for the apparent absence of hatching activity during the week of July 4 - 10, and the hatch may be more uniformly distributed over the 3-week period than is indicated by Fig. 18.

Regardless of the exact week during which most broods hatched, nesting phenology in 1971 appeared to lag one month behind 1968, possibly due to spring weather conditions. Fifty percent of the broods had hatched by June 5th in 1968, and hatching was completed by July 3rd (Fig. 19). Fifty percent of the broods were not hatched until June 26th in 1971, and hatching continued until July 31st. Calculations of nest establishment dates indicated that the peak periods of nest establishment were April 18 to May 8 in 1968, compared to May 23 - 27 in 1971, a difference of at least 3 weeks (Fig. 20). Temperatures and precipitation were both above normal for April and early May in 1968, but were below normal in 1971 (Fig. 5 and Fig. 6). Wagner et al. (1965) found a significant positive correlation between early nesting and above-normal April and May temperatures in Wisconsin, thus offering a possible explanation for the later nesting in 1971.

Severe weather conditions in July, however, may have affected the hatching chronology found in 1968 more seriously

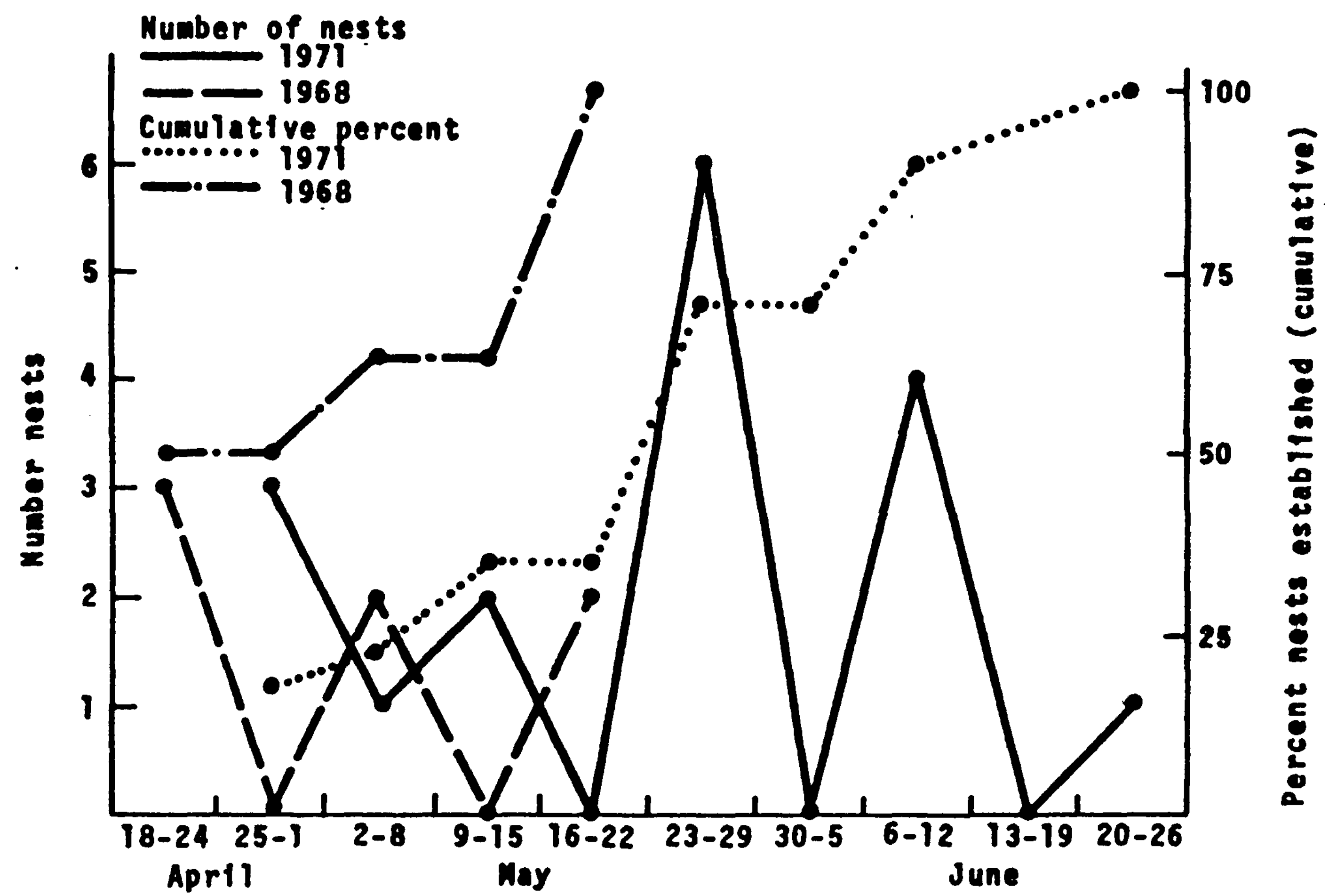


Figure 20. Chronology of nest establishment for the Check Area, 1968 and 1971.

than temperatures in April and May. No broods were seen on the Check Area following the July 17th cloudburst, indicating that rainfall and associated flooding probably caused mortality to chicks and destroyed nests. Thus, broods which normally would have been seen later in the summer may have been eliminated, and nesting phenology made to appear to precede that for 1971 by nearly a month. Nearly the same total number of broods were produced during each week in June in both years (Fig. 18), even though the cumulative percentage produced in each week was greater in 1968 (Fig. 19). Nest establishment dates indicated a similar pattern was followed in both years, with 1968 preceding 1971 by one week (Fig. 20), possibly due to the warmer temperatures in that year. Thus, similar hatching chronologies and nesting phenologies might have been found in both years, had not the cloudburst interferred. The hatching chronology found in 1971 will be assumed more nearly typical and used in later discussions, since a larger sample was found in that year and extreme weather conditions were absent.

Hunter surveys

Post-card questionnaire. Almost no response resulted from a post-card questionnaire distributed to farmers or placed on automobile windshields in 1968. The only return came from one party that was personally contacted and agreed to complete the questionnaire when they had finished hunting. Because of his induction into military service, the investigator could not return to the study areas following the opening week-end of hunting season to determine if farmers failed to distribute the questionnaire, or whether hunters neglected to complete and mail cards to the Unit.

Hunting pressure. Hunter interviews conducted during the opening week-end of pheasant hunting season indicated that several hunting parties used the Check Area in 1968, 1970 and 1971. Hunters were found on the Amish Area only in 1970. Four hunting parties (totaling 35 hunters) were contacted on the Check Area in 1968, compared to 8 parties (35 hunters) in 1970 and 7 parties (29 hunters) in 1971 (Table 14). Only 2 hunting parties (10 hunters) were contacted on the Amish Area, both in 1970. All of the Amish farmers allowed hunting on their land, but one farmer stated that few hunters had used his farm in recent years, due to lack of previous success.

Hunting pressure on the Check Area decreased from 1968 to 1971, and a shift occurred from non-resident to local hunters. The total gun-hours expended (number of hunters times the number of hours each hunted) declined from 90 in 1968 to 39 in both 1970 and 1971 (Table 14). The average distance traveled (from home town to the Check Area) decreased from 63 to 19 miles during the same period. The large hunting parties contacted in 1968 (averaging 9 hunters) probably inflated the effort expended that year, since even a short time spent in the field by that many hunters added considerably to the total gun-hours. All of the large groups contacted in 1968 were from Dubuque or Cedar Rapids, Iowa, and had hunted in that

Table 14. Hunting pressure, pheasant harvest and hunter success during the first week-end of pheasant hunting season, 1968, 1970 and 1971

	Amish Area			Check Area		
	1968	1970	1971	1968	1970	1971
Hunting pressure						
Parties contacted	0	2	0	4	8	7
Total hunters	0	10	0	35	35	29
Average party size	-	5	-	8.8	4.4	4.1
Total hours hunted	-	1.5	-	12.3	5.9	8.5
Total gun-hours	-	8.5	-	90.3	38.5	39.5
Average miles traveled	-	26.7	-	62.7	41.7	18.9
Pheasant harvest						
Adults	0	0	0	1	0	7
Juveniles	0	0	0	0	6	18
Total	0	0	0	1	6	25
Age ratio (juvenile : adult)	-	-	-	0:1	6:0	2.6:1
Hunter success						
Birds per hunter	0	0	0	.03	.17	.86
Birds per gun-hour	0	0	0	.01	.16	.6
Gun-hours per bird	0	0	0	90.3	6.4	1.6
Estimated number of pheasants seen						
Hens	0	0	0	24	37	44
Cocks	0	0	0	11	45	55
Total	0	0	0	35	82	99

part of Buchanan County for several years, because of the good pheasant populations they had previously found there. Most of the parties contacted in 1970 and 1971, however, were local farmers, or relatives of local farmers, and had made arrangements with residents of the Check Area to reserve their farms for the opening week-end. Other hunters were observed driving through the Check Area, but were unable to secure permission to hunt, indicating that reservation of farms for local hunters was more effective in discouraging hunting by non-residents than the low hunting success experienced in 1968.

Pheasant harvest and hunter success. The number of pheasants killed on the opening week-end on the Check Area increased each year during the 3 years hunters were interviewed. No birds, however, were harvested on the Amish Area during this period. Hunters did not report sighting any pheasants on the Amish Area, indicating that populations there were extremely low. Only 1 cock is known to have been bagged on the Check Area in 1968, compared to 6 in 1970 and 25 in 1971 (Table 14). Only 1 bird was harvested per 30 hunters in 1968, compared to 1 bird per 5 hunters in 1970 and nearly 1 bird per hunter in 1971. The number of gun-hours required to harvest one pheasant decreased from 90 in 1968 to 6 in 1970 and 1.6 in 1971. Similarly, 1 hour of hunting produced only 0.01 birds in 1968, 0.2 birds in 1970 and 0.6 birds in 1971. Thus, the effort expended to harvest a pheasant decreased as the number of birds harvested increased, indicating that more

Table 15. Winter pheasant census results obtained on the Amish and Check Areas, 1971 and 1972

Acres searched[a]	2040	40	1776	1036
Man-hours expended	31	6	27	8
Pheasants observed				
Hens	9	6	13	90
Cocks	5	4	7	22
Unknown	0	0	4	9
Total	14	10	24	121
Sex ratio (Hens:cock)	1.8:1	1.5:1	1.9:1	4.1:1
Pheasants per section	5	4	7	38

[a]All cover types were searched in 1968. Only those cover types which contained pheasants or pheasant sign in 1968 were searched in 1971.

birds were available in 1971 than in previous years.

A comparison of the estimated number of pheasants seen by hunters indicates that more pheasants existed on the Check Area in 1968 and 1970 than were accounted for by the harvest (Table 14). Only 35 pheasant sightings were reported in 1968 (60 percent less than in 1971), and 82 birds were reported in 1970 (20 percent less than in 1971). These estimated are subject to considerable error, since hunters could only provide educated guesses. They do indicate, however, that the increase in harvest between years was greater than increases in the number of birds seen, especially from 1970 to 1971. This may be explained by poor hunting conditions found in 1968 and 1970. All hunting parties contacted in 1968 complained about large acreages of corn still not harvested (Table 10), which made it difficult to flush and shoot pheasants. Strong winds and cold temperatures in 1970 discouraged hunters from spending long periods in each field and caused many missed shots. These factors may have lowered the harvest and created the appearance of smaller pheasant populations than actually existed.

Age ratios. One adult bird was harvested in 1968 and only juvenals were taken in 1970, preventing the determination of age ratios for those years. A ratio of 2.6 juvenals per adult found in 1971 yielded an average of 2.7 young per hen when corrected for winter sex ratios obtained in 1971 (Wagner et al. 1965). This figure is less than 50 percent of the average brood size of 6.2 chicks (determined from the latest sighting of each brood) observed on roadside counts, but the difference is probably caused by the small number of cocks harvested.

Winter census

Populations. Winter pheasant censuses were conducted on the Amish Area the week-end of January 9-10 and February 4-5, 1971, following a week of blizzard activity in both cases. Temperatures were below 5°F., wind velocities exceeded 20 mph and accumulated snow depths were greater than 20 inches, with severe drifting. Counts were conducted on the Check Area the week-end of March 7-9, under milder weather conditions. Temperatures ranged from 15 - 20°F. and winds were calm, but snow depth still exceeded 20 inches. These conditions were marginal to unacceptable for a winter census, but conditions were not expected to improve later in the month. Counts on both study areas were conducted the week-end of January 28-30, 1972, under wind and temperature conditions similar to those existing during the Amish Area census in 1971, but with snow depths of only 8-10 inches.

The 1968 winter counts revealed that nearly twice as many birds resided on the Check Area, and that weather conditions during the Check Area census made this a minimal estimate (Table 15). Thirty-one man-hours spent searching the entire Amish Area produced only 14 pheasants (5 birds per section), while 27 man-hours spent searching the Check Area produced 24 pheasants (7 birds per section). All 14 birds seen on the Amish Area were concentrated in one 4-acre drainage ditch in the northern half of the Area (Fig. 10). The only other pheasant sign observed was a trail of several fresh tracks leading from this ditch to an unharvested corn field one-fourth mile to the southwest, and from that corn field to an adjoining farm shelter belt where a farmer provided a self-feeding station of sheller corn. The 24 pheasants observed on the Check Area were found scattered in small groups throughout the Area. Most were located along the margins of corn fields or near waste areas. All waste areas were heavily covered with pheasant tracks, and 108 separate pheasant roost were found. Snow had not fallen for a week prior to this census, indicating that the same birds left much of this sign. There appeared to be more activity than could be accounted for by 24 pheasants, however, and tracks were found along fencerows and in cover areas where no birds were located. It is felt that milder weather conditions during this census allowed the birds to roam farther from permanent cover, resulting in a smaller population estimate than actually existed.

Winter counts in 1972 indicated similar populations existed on the Amish Area as in 1971, while Check Area populations increased 5 times (Table 15). Only those cover types which pheasants had utilized in 1971 were searched. Six hours of searching on the Amish Area produced 10 pheasants (4 birds per section), while 8 hours of searching on the Check Area produced 121 pheasants (38 birds per section). Seven of the 10 Amish Area pheasants were flushed from the same drainage ditch as in 1971, but the remaining three were located along a recently-dug drainage ditch in the southern half of the study area (Fig. 11). Of the 121 Check Area pheasants, 90 were flushed from the three waste areas along the north side of the study area (sec. 26 and 30), 11 were found in a waste area in the center of sec. 25, and 10 were located in a waterway in the SW 1/4 sec. 30 (Fig. 13). No other pheasant sign was observed on either study area, indicating that severe weather conditions were holding the birds close to cover and that this census was more nearly accurate for the Check Area than that obtained in 1971.

Winter cover. Only 35 acres (2 percent of the Amish Area) were used as pheasant winter cover in 1971, and 8 acres (0.4 percent) in 1972. These acreages constitute 85 percent of the potential winter cover available in 1971, but only 20 percent of that available in 1972 (Fig. 9). The total acreage used by pheasants on the Check Area in 1971 was not estimated because of their apparent dispersal, but 78 acres (4 percent of the entire Area and 73 percent of all available winter cover were utilized in 1972). The most common areas of potential winter cover not used were farm shelter belts. Only one of the five shelter belts in which cover was apparently sufficient was used on the Amish Area in 1971, while none was used in 1972. None of the eight suitable shelter belts on the Check Area were used in either year. No apparent explanation was available for the non-use of these areas. It is possible that sufficient cover exists in waste areas for the small number of pheasants present on both study areas, and birds are not forced into shelter belts.

Sex ratios. Differences in sex ratios found on the two study areas probably reflect the different pressures exerted on their respective pheasant populations. Sex ratios of less than 2 hens per cock were found on the Amish Area in both years, and on the Check Area in 1971. Sex ratios on the Check Area in 1972, however, were greater than 4 hens per cock (Table 15). The small number of pheasants observed precludes any conclusions from these sex ratios (except for the Check Area in 1972), but they may indicate a trend in populations. Sex ratios approaching 1:1 might be expected on the Amish Area, since few cocks are apparently removed by hunting. Hunting mortality of cocks on the Check Area, however, should widen sex ratios.

The difference in sex ratios on the Check Area between 1971 and 1972 may be associated with the milder weather conditions existing in the earlier year, and by an apparent behavioural difference between hens and cocks. Hens tend to flock together in large groups in cold weather, while cocks are more likely to be found alone or in small flocks (Nelson 1940). In 1972, 6 of 22 cocks were flushed in flocks of 6 birds or fewer, but only 8 of 90 hens were found in such groups. In 1971, when milder weather conditions existed, all were found in small groups, indicating that dispersal of hens was probably greater at that time. Thus, fewer hens per cock may have been found than actually existed.

Spring census

Crowing-cock counts. Crowing-cock counts were made in the spring of 1971, the only year favorable weather conditions existed while the investigator was present. Counts were made on May 7, 8, 9 and 17, towards the end of the period of peak pheasant crowing activity in northern Iowa (Nomsen 1968a). Census conditions were excellent all 4 days counts were made - wind velocities were less than 2 mph, skies were clear and noise interference at all stops was minimal. Rainy weather every week-end from April 15th through May 7th prevented counts being made in 1972.

More pheasant crowing activity was heard on the Check route than on the Amish route, regardless of the order or direction routes were driven. More cock-calls were heard on the Check route every morning a count was made, with a maximum of 180 cock-calls heard on one count on the Check route (Table 16), compared to only 19 on the Amish route (Table 17). A mean of 9.9 cock-calls was heard per stop for all counts on the Check route, about 8 times greater than that heard on the Amish route (1.2).

Some variation existed between the number of cock-calls heard at each stop on the same route on the same day, but the most variation existed between days on the same route. At least 9 counts are needed on a 10-mile route to obtain a mean number of cock-calls per stop within 10 percent of the true mean at 95 percent confidence (Kozicky 1952), indicating that the small sample of counts contributes much to this variability. Much of the variability was eliminated by grouping the counts into those obtained when the route was driven prior to sunrise (primary counts) and counts obtained when the route was driven after sunrise (secondary counts). A chi-square test revealed that significantly more total cock-calls were heard on the primary counts than secondary counts on both routes ($P < .01$ for the Amish route and $P < .005$ for the Check

Table 16. Comparison of the number of pheasant cock-calls heard at each stop on the Check Area crowing-cock census route, 1971

Date	1	2	3	4	5	6	7	8	9	10	Daily total	Cock-calls per stop
May 7[a]	1	1	3	2	9	1	5	2	2	3	29	2.9
8[b]	30	26	26	15	17	16	12	19	10	9	180	18.0
9[a]	9	5	6	2	6	4	11	6	14	9	72	7.2
17[b]	9	8	10	6	13	11	17	9	19	15	117	11.7
Total	49	40	45	25	45	32	45	36	45	33	398	9.9
Cock-calls per stop	12.3	10	11.3	6.3	11.3	8	11.3	9	11.3	8.3		

[a]Count began approximately 15 minutes after sunrise, following the Amish route count.

[b]Count began 40 minutes before sunrise, preceding the Amish route count.

Table 17. Comparison of the number of pheasant cock-calls heard at each stop on the Amish Area crowing-cock census route, 1971

Date	1	2	3	4	5	6	7	8	9	10	Daily total	Cock-calls per stop
May 7[a]	3	4	3	7	0	0	0	0	2	1	19	1.9
8[b]	0	2	2	1	0	3	0	0	1	2	9	0.9
9[a]	1	0	0	1	3	0	3	2	3	1	14	1.4
17[b]	1	0	1	2	0	0	1	1	0	0	6	0.6
Total	5	6	6	11	3	3	4	3	6	4	48	1.2
Cock-calls per stop	1.3	1.5	1.5	2.8	.8	.8	1	.8	1.5	1		

[a]Count began 40 minutes before sunrise, preceding the Check route count.

[b]Count began approximately 15 minutes after sunrise, following the Check route count.

route). No other factors other than timing of the count in relation to sunrise, were apparently responsible for this difference between primary and secondary counts. Weather conditions were ideal for all counts, and there was no significant correlation between dewfall and the number of cock-calls heard on either the Amish route ($r = -.654$) or the Check route ($r = .457$).

Nearly 90 percent fewer cock-calls were heard on the Amish route, comparing either primary or secondary counts (Table 18). This substantiates other census data, which indicated larger pheasant populations resided on the Check Area. Nearly three times more cock-calls (14.9) were heard per stop on primary counts on the Check route than on secondary counts, while twice as many were heard on primary counts on the Amish route. Since primary counts were made during the period of peak crowing activity each day, they are thought to be more representative of pheasant populations on the two areas and will be used in all further comparisons.

Table 18. Mean number of pheasant cock-calls heard per 2-minute stop on the Amish and Check Area crowing-cock census routes, 1971

	Amish route	Check route
Primary count[a]	1.7	14.9
Secondary count[b]	0.8	5.1
All counts	1.2	

[a]Counts begun 40 minutes before sunrise, according to the standardized technique described by Kimball (1949).

[b]Counts begun approximately 15 minutes after sunrise.

Application of Kimball's (1949) method for estimating total pre-breeding season populations from winter sex ratios and the mean number of cock-calls heard per stop indicates that the Amish Area population totalled only 5 birds (2 cocks and 3 hens), while Check Area populations totalled 43 birds (15 cocks and 28 hens). These estimated totals can not be regarded as precise since there was doubt regarding the sex ratio determined for the Check Area in 1971. The totals were also probably inflated by cock-calls which did not originate on the study areas. Regardless of what method is used to compare populations on the two areas (total cock calls, primary or secondary counts, population estimates), however, the presence of substantially more pheasants on the Check Area is indicated.

Harem sizes. More than three times as many pheasants were observed while making crowing-cock counts on the Check route, but harem sizes were about the same on both Areas (Table 19). If all birds observed are considered, the harems observed on the Check Area averaged only 1.3 hens per cock (18 hens:14 cocks). Only 7 cocks were seen with all 18 hens, however, and an average harem size of 2.4 hens per cock is obtained if only those cocks are considered. The other 7 were all observed crowing and seemingly in vigorous health. The period of nest establishment had already started (Fig. 20), and hens associated with these cocks may not have been active at this time. Since no special attempt was made to locate pheasants while making these counts and many probably escaped notice, the latter figure is thought to be more representative of typical harems on the Check route.

All nine birds seen on the Amish Area were located in the same segment of a single mile, indicating that some birds were observed more than once. A cock was seen once with two hens, once with four hens and once alone. Thus, one cock and four hens were probably the only pheasants seen. If all birds seen are considered without regard to location, however, Amish Area harems averaged 2 hens per cock, essentially the same size as Check Area harems.

Table 19. Comparison of pheasant harem sizes on the Amish and Check Areas, determined from pheasants seen while making crowing-cock counts (May 7, 8, 9 and 17)

	Amish Area	Check Area
Number of pheasants seen		
Hens	6	18
Cocks	3	14
Total	9	32
Ratio (Hens:Cock)	2:1	1.3:1
Cocks with hens	3	7
Cocks without hens	0	7
Number of harems	3	7
Number of hens in harems	6	17
Average harem size	2	2.4

Non-hunting mortality

Only two cases of pheasant mortality were found on the Amish Area. One nesting hen was struck and probably killed by a hay mower in 1968. Large clumps of bloody feathers and one leg cut off at the knee joint were found, but the hen was not located. One 2-week old chick apparently killed by a hay mower was found in 1971.

Five instances of pheasant mortality were verified on the Check Area in 1968. The wing and sternum of a cock pheasant were found in a road ditch, but the probable predator could not be determined. One hen was found on a road after it had been struck by a car; one 3-week old chick was found hanging by a wing from a barbed wire fence; one wing of a hen was found on a road, but no other evidence was present, and pieces of a rodent-chewed egg were found in a ditch. In 1971, one hen and one cock were found after being struck by cars, and a large clump of feathers was located while searching a waste area during the winter census. Tracks in snow indicated a dog had dug out a cock roosting under a snowbank.

Thus, non-hunting mortality appears to be greater on the Check Area, probably due to the greater pheasant population found there. The number of road kills accounted for was greater on the Check Area, as might be expected considering the differences in means of transportation, with horses commonly used on the Amish Area. Roads on the Amish Area, however, are also well-traveled by car-driving neighboring farmers, local businessmen and sight-seers. The different population levels may be more important in contributing road kills than the amount and type of traffic on this area.

Nesting Study

Nest searching proved to be the most time consuming and least productive aspect of summer research activities. About 500 acres of potential pheasant nesting cover were searched in each year (Table 20), but only 4 nests were found in 1968 and 8 in 1971 (Table 21). Two-hundred and fifteen man-hours were spent searching for nests on the Amish Area in 1971 (75 percent of which were spent in hay and oats), compared to 240 man-hours spent on the Check Area (65 percent in waste areas and oat fields). Differences between Areas in man-hours expended in each cover type reflect different land use patterns, since the same sampling procedures were used on both Areas. Recurcurent rain showers in June and July of 1968 hindered field research activities and delayed mowing to the extent that less time was spent searching than in 1971, and smaller percentages of most cover types were searched (Table 20). No record of man-hours expended was kept in 1968. Nest searching in undisturbed cover (waste areas and road ditches) was not hindered as greatly by rain, and similar percentages of these cover types were searched in both years. The acreages searched in 1968 represent 49 and 43 percent of the potential nesting cover on the Amish and Check Areas, respectively, compared to

Table 20. Number of acres searched for nests and effort expended in each cover type on the Amish and Check Areas, 1968 and 1971

	Amish Area			Check Area		
	Acres searched	Percentage of total	Man-hours	Acres searched	Percentage of total	Man-hours
1968						
Hay	104.2	53.0	-[a]	43.6	64.0	-[a]
Oats	100.	32.1	-	38.2	26.3	-
Diverted acres	27.5	100.0	-	29.7	16.1	-
Waste areas	27.2	72.7	-	42.6	63.3	-
Road ditches	37.4	50.0	-	37.0	50.0	-
Total	296.7		-	191.1		-
1971						
Hay	138.8	88.2	88.0	40.3	77.8	26.0
Oats	103.9	36.4	64.0	98.1	96.6	56.0
Diverted acres	25.2	45.7	10.0	17.4	22.8	12.5
Waste areas	10.5	77.2	9.0	75.9	90.7	95.0
Road ditches	18.7	50.0	43.5	18.3	50.0	48.5
Total	297.1		214.5	250.0		238.0

[a]Information not recorded.

58 and 83 percent searched in 1971. More total acres were searched on the Amish Area (297 acres) than on the Check Area (191 acres) in 1968, because harvest chronologies for hay and oats were less delayed by rain on the Amish Area (Fig. 16). Similar total acreages were searched on both Areas in 1971, reflecting the similar harvest chronologies which were found under more nearly normal weather conditions (Fig. 17).

Few conclusions can be drawn on nesting ecology because of the small number of nests found in both years, but some trends in habitat preference and nest success are indicated.

Hay fields appear to be the preferred nesting habitat of pheasants on the Amish Area (Table 21). Six of seven nests found were in hay, with the other located in an oat field. Three hayfield nests were destroyed by mowing activities (2 in 1968 and 1 in 1971), 2 were successful (1 in each year) and the remains of 1 nest were too weathered to determine its fate. Thus, one-third of all hay field nests were successful and one-half were destroyed by mowing. The one oat field nest was also successful, indicating an over-all nest success of 43 percent for the Amish Area. No other nests were reported by farmers.

Waste areas were the most heavily utilized nesting habitat on the Check Area, with 4 of 5 nests located in such cover (Table 21). Three of these nests were successful, while the fourth appeared to be a "dump" nest that was not incubated. One nest found in an oat field was successful, indicating that 80 percent of all Check Area nests hatched. Five nests were

Table 21. Nest production by cover types, 1968 and 1971

Cover type	No. nests	No. successful nests	Calculated[a] number nests	Nests per 100 acres
		1968		
		Amish Area		
Hay	3	1	11	5.6
Oats	1	1	6	1.9
Waste areas	0	0	0	0
Total	4	2	17	
		Check Area		
Hay	0	0	0	0
Oats	0	0	0	0
Waste areas	0	0	0	0
Total	0	0	0	0
		1971		
		Amish Area		
Hay	3	1	7	4.3
Oats	0	0	0	0
Waste areas	0	0	0	0
Total	3	1	7	
		Check Area		
Hay	0	0	0	0
Oats	1	1	2	1.9
Waste areas	4	3	9	10
Total	5	4	11	

[a]Calculated number of nests =

$$\frac{\text{Actual number} \times \frac{1}{\text{sample size}}}{\text{Fraction of cover type searched}} .$$

reported by farmers in 1968, but could not be relocated by the investigator. Three were in a diverted acres field that was disked immediately after mowing, thereby destroying all sign of the nests, and two were in hay fields in which substantial second growth had occurred by the time the nests were reported.

Comparing the calculated number of nests found (Table 21) indicates that 24 nests were initiated on the Amish Area during the 2 years (17 in 1968 and 7 in 1971), more than twice as many as were initiated on the Check Area (11 in 1971). The calculated number of nests was arrived at by expanding the sample searched in each cover type to include its total acreage. A comparison of the location of nests and cover types utilized, however, indicated that the calculated number of nests found on the Amish Area may be too high, while that found on the Check Area is probably too low. All nests found on the Amish Area were located in the northern half of sec. 25 (Fig. 10 and 11), all within three-fourths mile of the drainage ditch used as the principal source of winter cover on the Area. No pheasant activity of any kind was observed in the southern half of the study area prior to the winter of 1972. Thus, including hay and oat fields found in the southern half when computing the calculated number of nests for the entire Amish Area may have produced an unrealistically large total. If only hay and oat fields located on the northern half of the Area are considered, 14 nests were initiated (8 in 1968 and

6 in 1971). Most of the nests found on the Check Area were in waste areas, which were more difficult to search than either hay or oat fields. Ground litter was dense, and the lush growth of new vegetation made it difficult to locate nests if a hen was not flushed. Lyon (1965) estimated that 35 percent or more of the nests established in waste areas are often missed by searchers, and it is felt that several nests could have been missed during this study. Less total acreage was searched on the Check Area in 1968, also, which probably resulted in fewer nests being located. Thus, the calculated number of nests found on the Check Area is probably a minimal estimate.

Nesting densities based on the calculated number of nests found in each cover type indicate that fewer nests were found per 100 acres of available nesting habitat on the Amish Area than on the Check Area. About five nests were found per 100 acres of hay on the Amish Area (Table 21), considerably fewer than have been reported for other studies in Iowa (Baskett 1939, Lyon 1965, Egbert 1968). Similar low densities of 2 nests per 100 acres were found in oat fields on both Areas. A density of 10 nests per 100 acres found in waste areas on the Check Area, however is roughly comparable to or exceeds that found in the other studies. Direct comparisons of nest densities between the two study areas may not be valid, since similar cover types can be compared in only one case. They do indicate, however, that Check Area pheasants are utilizing available nesting habitat more heavily than Amish Area pheasants.

Clutch sizes, fertility and hatchability rates for eggs found on both Areas were apparently normal, indicating that production was good in the few nests discovered. The fact that no active nests were found on the Check Area and only two (both destroyed by mowing) were located on the Amish Area, compounded the problem of the small number of nests when making these determinations. The two incubating clutches contained 10 and 11 eggs, while the other nests found on the Amish and Check Areas were too weathered to be sure of the exact number of eggs hatched. Considering the best estimates that could be made, however, indicated the mean clutch size was 10.0 eggs on the Amish Area (range 7 - 12) and 10.2 on the Check Area (range 6 - 15). All 23 incubating eggs were fertile, and no unhatched or infertile eggs were discovered in successful nests on either Area. The dump nest found on the Check Area had not been incubated and fertility could not be determined.

Drainage ratings and vegetation types found in road ditches

Wet ditch bottoms apparently discourage nesting in road ditches around both study areas, especially in 1968 (Table 22). Ninety percent of the ditch segments searched on the Amish Area in 1968 had wet bottoms or showed evidence of submersion during the spring (drainage ratings 1, 2, 3 or 4), and 70 percent were still muddy or contained standing water (1,2 or 3). Sixty-seven and 39 percent of the Check Area

Table 22. Comparison of vegetation types and drainage ratings of ditch bottoms (1/10-mile segments) located around the Amish and Check Areas, 1968 and 1971

Vegetation type	Drainage rating[a] 1	2	3	4	5	Total
	Number 1/10-mile segments					
	1968					
Amish Area						
Bluegrass	2	9	8	5	3	27
Brome	0	1	0	3	1	5
Bluegrass-brome	0	4	4	2	1	5
Sloughgrass	1	0	0	0	0	1
Bluegrass-sloughgrass	1	5	1	0	0	7
Total	4	19	13	10	5	51
Check Area						
Bluegrass	0	0	1	3	9	13
Brome	2	2	6	12	9	31
Bluegrass-brome	2	1	3	0	1	7
Sloughgrass	0	0	0	2	0	2
Bluegrass-sloughgrass	1	0	2	1	0	4
Total	5	3	12	18	19	57
	1971					
Amish Area						
Bluegrass	3	2	1	6	6	18
Brome	1	0	2	2	4	9
Bluegrass-brome	0	1	1	0	5	7
Sloughgrass	2	0	0	3	0	5
Bluegrass-sloughgrass	3	0	4	3	2	12
Total	9	3	8	14	17	51
Check Area						
Bluegrass	0	1	0	4	10	15
Brome	2	1	4	11	8	26
Bluegrass-brome	1	0	3	2	4	10
Sloughgrass	0	1	1	2	0	4
Bluegrass-sloughgrass	0	0	0	2	0	2
Total	3	3	8	21	22	57

[a]1=Standing water in more than one-half of the segment.
2=Isolated areas of standing water, with some dry areas.
3=Muddy or nearly dry bottom.
4=Dry bottom, but evidence of prior submersion.
5=Dry bottom with no evidence of prior submersion.

segments were in these respective categories. In 1971, 67 percent of the Amish Area ditches had been submerged and 35 percent were still wet, compared to 44 and 25 percent on the Check Area. Thus, more Amish Area ditch segments were wet in both years, and ditches around both Areas were wetter in 1968 than in 1971. It is felt that the greater-than-normal rainfall which occurred in 1968 caused unusual flooding, since several of the segments which were completely submerged in 1968 showed no evidence of submersion in 1971. Tile drain outlets appeared to be the most common cause of road ditch flooding in 1971, and were more common on the Amish Area. Check Area farmers had more natural water-ways to use for drainage.

Vegetation types found in dry ditch segments indicated that nesting cover was too sparse for nesting in some segments on both Areas, but could not explain the complete absence of any ditch nesting in either year. Bluegrass was the principal vegetation found in 53 and 35 percent of Amish Area ditch segments in 1968 and 1971, respectively, compared to 23 and 26 percent of Check Area ditches. Bluegrass is often too sparse to provide quality nesting cover (Lyon 1965), but some of the stands appeared dense and tall enough to conceal nests. Segments with brome or bluegrass-brome combinations totalled 20 percent of all Amish Area segments in 1968 and 31 percent in 1971, compared to 67 and 63 percent of Check Area segments. These grasses appeared to offer excellent nesting cover, but were not utilized. Sloughgrass and bluegrass-sloughgrass combinations were usually found in wet segments and were unsuitable for nesting. Therefore, a combination of wet ditches and sparse vegetation probably discouraged nesting in ditch bottoms on the Amish Area. Nearly two-thirds of the Check Area ditches were dry enough and had sufficient vegetation to allow nesting, however, and ditches around both Areas had a dry "shelf" 1 - 2 feet wide along the fencerow, which could have held nests. Many of these shelves were grazed on the Amish Area, but a few located adjacent to unpastured fields were heavily vegetated. No explanation was found to account for the complete non-use of road ditches for nesting.

DISCUSSION

Two limitations must be considered before any conclusions can be drawn about the effects of Buchanan County Amish agriculture on pheasant populations. First, the small number of pheasant observations obtained from many of the research activities precludes definite conclusions about many aspects of pheasant ecology, especially in 1968. Comparisons, therefore, will have to be based on indicated trends. Secondly, the interrupted nature of the study prevented collection of population data over a continuous period. Thus, population differences between the two Areas, and fluctuations between years on the same Area, may have been influenced by phenomena occurring when the study was inactive, and which were not recorded. Year-around data on the effects of Amish agriculture on pheasants was collected for only 1 year, requiring comparisons between years when no interim information is available. With these limitations in mind, some general conclusions regarding the effects of Amish land use and farming methods can be made.

Populations

Comparing pheasant populations on the two study areas is complicated by the difference in Check Area populations recorded in 1968 and 1971. Amish Area populations remained small and relatively stable in both years, with similar results obtained from all comparable census methods. Winter censuses and spring crowing-cock counts were not conducted in 1968 and can not be compared. Hunter surveys, however, indicated no cocks were harvested during the opening week-end of pheasant hunting season in either 1968, 1970 or 1971 (Table 14), and summer roadside counts indicated the slight decrease observed in birds per mile (from 0.06 to 0.02) between 1968 and 1971 was not statistically significant (Table 12b). No broods were observed on the Amish Area in either year, and a similar number of nests were found in both 1968 and 1971. Thus, it is assumed that populations on this Area changed little from 1968 to 1971. A 26 - fold increase in birds observed per mile (from 0.15 to 3.9) was recorded for Check Area roadside counts, however, and the number of birds harvested increased from 1 to 25. The increased harvest occurred under decreasing hunter effort. Only 6 broods were seen in 1968 (none on roadside counts), but 17 were counted in 1971. Part of this increase may be due to land use changes, but it is felt that extremely heavy rains in mid-summer of 1968 destroyed most pheasant production in that year, and that populations found in 1971 are more nearly typical.

The 270-acre increase (40 percent) in corn acreage, and corresponding loss of 108 acres (57 percent) of diverted acres (Fig. 7), were thought to be detrimental to the Check Area pheasant population. Diverted acres represent an important source of pheasant nesting cover if left unmowed (Schrader 1960, Joselyn and Warnock 1964, Nomsen 1969).

Smaller acreage losses of hay and oats were potentially important for the same reason. The 28-acre net gain in waste areas, however, may have compensated for these losses. No nests were found in diverted acres in either year, but 4 of 5 found in 1971 were in waste areas, and 3 were successful (Table 21). Furthermore, all 121 pheasants observed on winter counts in 1972 were in waste areas, 55 of which (46 percent) were flushed from the 35-acre pasture which had reverted to a weedy waterway. Thus, the development of an additional waste area probably improved both nesting and winter habitat on this Area, and contributed to the population increase.

The cloudburst which dropped 10-14 inches of rain directly on the study areas in 1968 was probably the major cause of the low population on the Check Area that year, as compared to the more normal rainfall year of 1971. No broods or chicks were observed after the storm (July 17th), even though six were seen in June and early July, and nesting phenology appeared to be progressing at a rate similar to 1971 (Fig. 20). Nomsen (1967) reported that persistent rain during the peak nesting period causes hens to abandon nests, and that newly hatched chicks may be killed by extremely heavy rainfall. Population reductions of one-third to one-half resulting from destruction of nests by flooding have been recorded in northern Iowa (Iowa Conservation Commission 1954). The cloudburst occurred during the peak hatching period observed in 1971 (Fig. 18), indicating that most chicks were young and vulnerable. Thirty percent of the hens were still incubating at that time (Fig. 19). Most of the hens in the later stages of incubation, as well as those hens which had hatched a brood, would not likely attempt to renest. If some hens did renest, however, the broods would not have appeared until August 25th (allowing 39 days for nest initiation to hatching), if nests were established immediately. Kuck et al. (1970) observed renesting intervals of 10 days in radio-monitored hens, indicating that hens which did renest would probably not hatch broods until early September, after roadside counts were completed. Thus some late broods may have been brought off that were not accounted for. The tendency of hens to use waste areas for nesting probably compounded the effect of the storm. Most of these areas were natural drainageways. Therefore, nests located there would have been inundated by a storm of this proportion. Thus, it is felt that most nests must have been destroyed and reproduction seriously affected.

Pheasant population data collected by the Iowa Conservation Commission support the theory that pheasant populations on the Check Area were unusually low in 1968. Commission personnel use two roadside count routes in Buchanan County. The Winthrop route begins 6 miles south of the Check Area and extends in a rectangular pattern east of the Area, 3 miles of which coincide with the eastern portion of the Check route. The Independence route runs diagonally across the southwest corner of the county. One count is secured on each of these routes (30 miles each) on a morning in mid-August when census conditions appear excellent. Since only one count was secured on Conservation Commission routes, direct comparisons of the number of birds seen per mile with those found in this study are probably not valid. They should, however, be useful in indicating population trends in the county.

The number of pheasants observed on the Winthrop route fluctuated by about 1 bird per mile (range 1.6 to 2.7) from 1962 to 1966 (Fig. 21), but in 1967 the greatest number observed in 6 years (3.4 birds per mile) was recorded (Nomsen pers. comm.). The greatest hen index and birds per mile observed since 1962 were recorded during spring crowing-cock and roadside counts throughout the eastern region of Iowa (16 eastern counties) in 1968, and production was expected to be good in that region (Nomsen 1968a). In 1968, however, a 60 percent decrease occurred in the number of birds observed per mile on the Winthrop route (Nomsen pers. comm.), followed by small increases in each succeeding year until the birds per mile average returned to its 1967 level in 1971 (Farris pers. comm.). The combined birds per mile average for the entire county followed a similar pattern, but data are not complete because the Independence route was not run each year. The number of birds observed per mile for all routes throughout the eastern region remained fairly stable or increased slightly during this period (Nomsen 1968b), indicating the local nature of this change. An increase in pheasants observed also

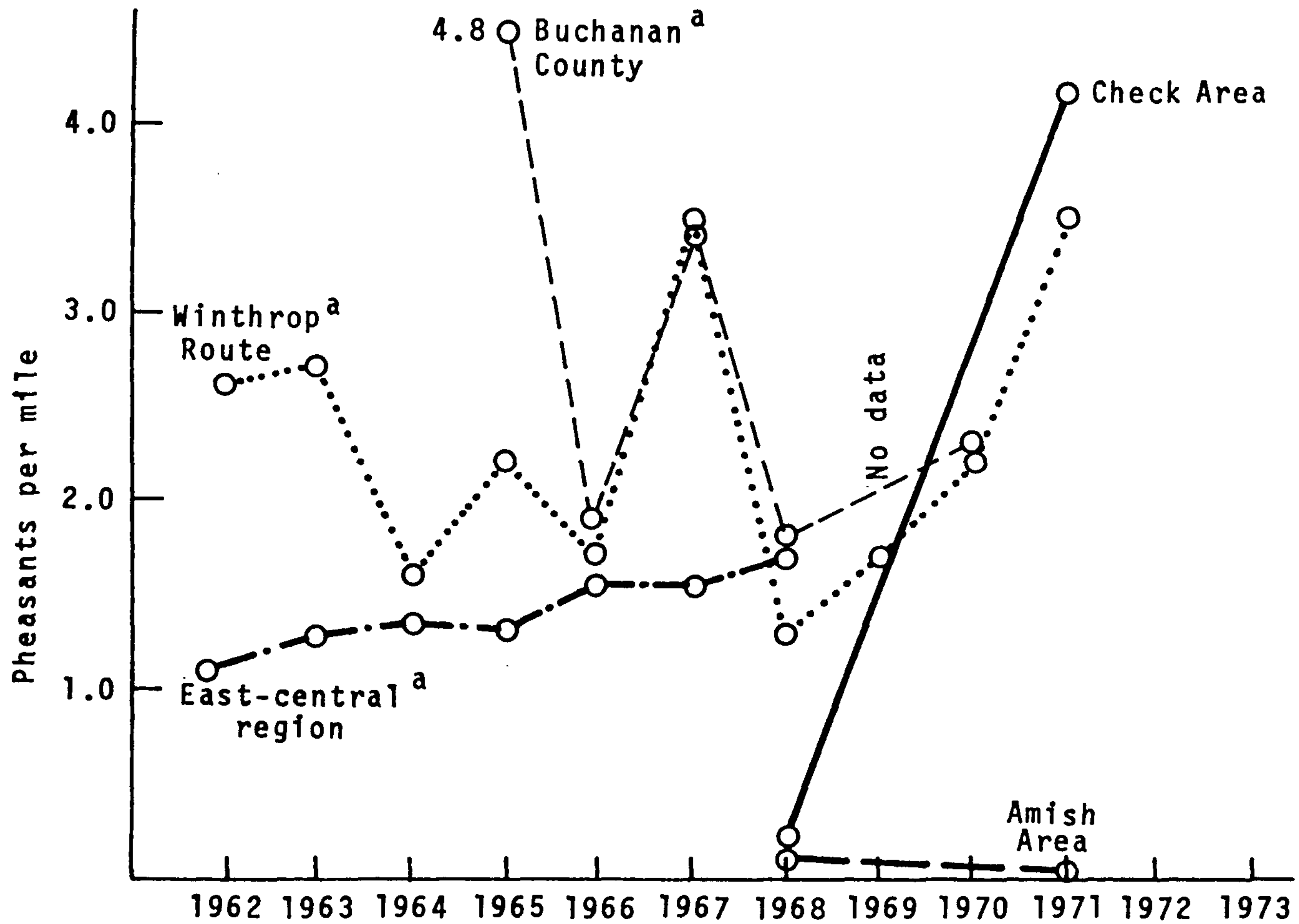


Figure 21. Trends in the number of pheasants (pheasants per mile) seen on roadside counts on the Amish and Check Areas, 1968 and 1971, with long-range trends for Buchanan County and the east-central region of Iowa included for comparison.

occurred throughout the eastern region from 1969 to 1970, due to generally favorable weather conditions (Nomsen 1969 and 1970). Data for 1971 are not yet available. It is felt that 1968 represents a low point in pheasant populations in Buchanan County (and the Check Area), caused by an extreme local weather event (the cloudburst). Increases in succeeding years appear to represent recovery in populations aided by favorable weather. Therefore, population differences between the Amish and Check Areas in 1971 are felt to be more representative of the typical situation than the similarities found in 1968. Comparisons between populations found in 1971 will be used in later discussions, unless otherwise indicated.

Two other possibilities must be considered in regard to population levels on both study areas prior to 1968. First, it is possible that low population levels existed on the Check Area, and the storm had little effect on production. The increase recorded from 1968 to 1971 could thus be due to some other factor not accounted for. Hunter surveys, however, indicated that hunters who had used the Check Area for several years had previously had good success there. Also, the 30 percent increase in waste areas was expected to be beneficial to pheasants, but did not explain why pheasants were found in parts of the Check Area in 1971 where none were found in 1968. Thus, it seems likely that a larger pheasant population traditionally existed on the Check Area than was found in 1968. It is also possible that a larger pheasant population existed on the Amish Area prior to 1968, but was unable to recover after the storm and remained small. Amish farmers, however, all reported few pheasants could be found on their farms for the past several years. Combined with the lack of hunting pressure and hunter success, and the fact that no broods were observed on the Amish Area in 1968, this seems to indicate that, although more pheasants may have been present prior to the storm, populations were still relatively small.

If population levels found in 1971 are considered more typical, all census results indicate a much larger pheasant population existed on the Check Area than the Amish Area. Nearly 195 times more pheasants were observed per mile on roadside counts on the Check route (Table 12); 25 pheasants were known to be harvested during the opening week-end of pheasant hunting season on the Check Area, compared to none on the Amish Area (Table 14); 38 pheasants were observed per section during the Check Area winter census, while only 4 pheasants per section were observed on the Amish Area (Table 15) and 90 percent fewer cock-calls (1.7 vs. 14.9) were heard during spring crowing-cock counts on the Amish Area (Table 18). A comparison of census results with farming methods employed on each Area indicates that different land use patterns and the extensive livestock operations of Amish farmers are probably responsible for this difference in pheasant populations.

Land Use Practices

A cursory examination of land use practices found on the two Areas seems to indicate the Amish Area is more favorable for pheasant populations than the Check Area. The Amish Area had about 45 percent of its total acreage (averaged for 1968 and 1971) planted in row crops, 25 percent in pasture, 17 percent small grains (oats and seeded diverted acres), 9 percent hay and 3 percent waste (Table 2). A total of 80 percent was under cultivation. This distribution of crop types compares favorably with those reported for the prime pheasant range in Iowa (Baskett 1947, Klonglan 1962 and Lyon 1965) and other states in the Midwest (Ginn 1962, Labisky et al. 1964, Wagner et al. 1965, Chesness et al. 1968), as previously described. The Check Area was more extensively cultivated (90 percent), with 65 percent in row crops, 14 percent small grains, 3 percent hay, 4 percent pasture and 6 percent undisturbed (Table 3). This cropping pattern approaches the upper limit of cultivation found on other good pheasant ranges, with more row crops and less hay and small grains than most, with one exception. Klonglan (1962) found pheasant populations approaching 125 birds per section on the Winnebago Research Area in northern Iowa, with a cropping pattern remarkably similar to that found on the Check Area (see p. 8). In general, the Amish Area has a higher percentage of hay and grain fields for nesting, more farm lots (traditional winter cover in Iowa), less row crops and is less cultivated than the Check Area, all of which indicates habitat conditions found on the Amish Area should be more favorable for pheasants. The fact that many times more pheasants were found on the Check Area, however, indicates that some factor not immediately apparent is causing the observed difference in populations. It is felt that the presence of more undisturbed cover on the Check Area, and grazing activities of Amish livestock, are co-factors in causing this difference, other Amish farming methods being less important.

<u>The importance of undisturbed areas for nesting cover</u>

The exact process by which these factors (grazing and lack of undisturbed cover) reduce Amish Area pheasant populations is not clear, but a combination of reduced nesting success and inadequate winter cover seems to be indicated. Nearly all recent pheasant nesting studies conducted in Iowa have indicated that most pheasant nests are established in hay fields, with oat fields, road ditches, fencerows and waste areas following in various orders, depending on the study (Baskett 1947, Klonglan 1962, Lyon 1965, Egbert 1968). These same studies, however, indicate that the greatest nest success (on a percentage basis) is in oat fields and undisturbed areas, since a high percentage of hay field nests are destroyed during hay mowing operations. These areas (oat fields and undisturbed areas) often produce a greater proportion of the total chick production than is indicated by the number of nests so located.

Nomsen (1969) states that more than 50 percent of all chicks hatched in northern Iowa are produced in oat fields.

A similar situation appears to exist on the Amish Area, although conclusions must be based on a total of only seven nests. Six of the 7 nests found in 2 years were located in hay fields (Table 21), at least one-half of which were destroyed. The only nest found in an oat field was successful. When a high proportion of hay field nests are destroyed, undisturbed cover (sloughs, waterways, road ditches, etc.) often assume a greater percentage of chick production by providing renesting cover (Robertson 1958, Wagner et al. 1965). Few such areas were located on the Amish Area. Only 3 percent of the Area consisted of undisturbed nesting cover, most of which was unsuitable. Road ditches appeared to be too wet (nearly two-thirds of the segments searched had previously been flooded) or had vegetation too sparse (more than 40 percent of all segments were in bluegrass) to provide adequate nesting cover in most segments. Waste areas totalled only 14 acres in 1971 (1 percent of the entire Area), and all were heavily grazed by Amish livestock. Of 34 miles of Amish Area fences, only 1 mile appeared to have enough vegetation to provide pheasant cover.

No nests were found in hay fields on the Check Area, and 4 of 5 found in waste areas (3 nests, 1 successful) and oats (1 nest) had hatched (Table 21). Thus, nesting hens on the Check Area appear to have less chance of losing their nests to agricultural activities. This is not intended to infer that

Check Area hens prefer undisturbed cover, or Amish Area hens seek out hay fields. Wagner et al. (1965) state that nesting densities in various cover types are a function of available cover, and it is felt that more hens utilize waste areas on the Check Area because more are available, while hay is the most abundant nesting habitat on the Amish Area.

A comparison of harvest chronologies for hay and oats with nesting phenology further illustrates the dangers of hay field nesting on both Areas. A similar nesting phenology will be assumed to exist for both Areas, due to their proximity, even though no broods were observed on the Amish Area. The peak of the hatch (Fig. 18) occurred approximately on July 1st in 1971 (the year with more normal weather conditions), and 70 percent of all nests had hatched by that time (Fig. 19). The 50 percent loss level for hay, however, occurred on June 21st on both Areas (Fig. 17), and 90 percent of all hay fields were mowed on the Amish Area by July 1st, 80 percent on the Check Area. Thus, only about 10-20 percent of all hay field nests on both Areas ought to have escaped destruction by mowing. Furthermore, if renesting was immediate, a second peak hatch could be expected about July 30th (again, allowing 39 days from nest establishment to hatching). But 50 percent of the oat fields were mowed by July 16th on the Amish Area and July 23rd on the Check Area, both dates preceding the expected date of the second (renesting) hatch. The effect would be even greater if a delay occurred before renesting began. Thus, most nests in hay and oat fields on both Areas can be expected to fail due to harvesting activities, with the earlier mowing practices of Amish farmers slightly increasing the chances of nest destruction on that Area. Since smaller acreages of hay were available on the Check Area, this effect of harvesting activities is expected to cause less damage to Check Area populations. Fewer nests were apparently established in hay fields on the Check Area, reducing the chances of nest destruction and probably requiring less renesting.

To summarize, it is felt that the lack of nesting cover in waste areas, and the apparent unsuitability of road ditches and fencerows, discourage nesting in other than hay fields on the Amish Area. A high percentage of these nests are apparently destroyed, and renesting attempts in oat fields can be expected to suffer the same fate. Check Area pheasants, however, are apparently forced to use waste areas for nesting cover, due to a lack of hay and oat fields, and may be more successful as a result.

The importance of undisturbed areas for winter cover

The presence of fewer undisturbed areas for winter cover and the reduction of their quality by grazing also seem to be factors limiting pheasant populations on the Amish Area. Grondahl (1952) found that sloughs and farm groves provide the best winter shelter in northern Iowa, and Nomsen (1968c) states that pheasants require brush and shrubs low to the ground to survive winter winds. Overgrazing of woodlots and marshes has been shown to decrease their value as winter cover (Robertson 1958, Wagner et al. 1965). Grazing activities on the Amish Area have removed most of the ground cover in both waste areas and farm groves. The only Amish waste area containing any brushy cover (willow and cottonwood shoots) contained all 14 pheasants flushed in 1971, and 7 of 10 in 1972. Only 5 of 16 farm groves had sufficient ground cover, of which only one was utilized. Waste areas on the Check Area were not grazed, and were heavily utilized as winter cover. All 121 pheasants observed in 1972 (when weather conditions were severe) were so located, with little pheasant sign seen in other habitats.

Assessing which of these factors, inadequate winter cover or poor nesting success, is the more important influence on pheasant populations on the study areas is difficult. The nesting densities found for hay (5 per 100 acres) and oats (2 per 100 acres) on the Amish Area are considerably lower than those found in other Iowa nesting studies (Table 21), indicating that much available nesting cover was not utilized. Several years of low pheasant production could have reduced populations to their current low level and prevented pheasants from utilizing all of the habitat available. Nest success on this Area, however, appears to be related to crop and nesting phenologies, which vary with the weather. Thus, more birds ought to be produced when harvesting is delayed (Wagner et al. 1965). Harvest chronologies in 1968 were greatly delayed, but no broods were observed on the Amish Area that year prior to the storm. Densities of 10 nests per 100 acres were found in waste areas on the Check Area in 1971 (Table 21), indicating pheasants on this area utilized waste areas more readily. Only 1 nest was found in oats, however, and none was located in hay, diverted acres or road ditches. Thus, much available nesting cover was not utilized on the Check Area. If nest success on this Area is normally as high as found in 1971 (80 percent), more pheasants ought to be nesting in these areas.

Nearly the opposite situation exists with regard to winter cover utilization. Only 20 percent of the potential winter cover on the Amish Area was inhabited by pheasants in 1972, compared to 73 percent on the Check Area. Farm groves were not utilized on either Area, however, and if they are not considered, all potential cover on both study areas was inhabited by pheasants. No reason was found for the non-use of apparently suitable farm groves. Even in 1968, when the worst blizzard in 35 years struck the study areas, birds were flushed only from waste areas. It is possible that enough cover exists on both areas to accommodate their resident pheasant populations, without requiring the use of farm shelter belts. Thus, the operation of some other factor is indicated.

Regardless of the exact process through which it works, the absence of undisturbed and ungrazed cover on the Amish Area seems to be the major limiting factor on its pheasant population. Check Area populations, which have more waste areas for both nesting and winter cover, were much larger when normal summer weather conditions existed.

Other Farming Methods

Other farming methods used by Amish farmers may have contributed to the small populations found on Amish farms, but such were not considered as important as Amish land use practices. Corn harvesting by hand apparently leaves less corn in the field than occurs with machine harvesting (Table 11). Winter food has seldom been a critical factor for Iowa pheasants, however, with cover considered more important (Grondahl 1952). Most winter losses of pheasants in northern Iowa resulted from suffocation and exposure, rather than starvation (Klonglan 1971). More corn and soybeans were available in Check Area fields, indicating a potential difference in loss if food did become scarce. No evidence of starvation, however, was found on either Area during the winter census, and all birds flushed showed strong flight. Thus, the different amounts of field waste found on the two study areas is not considered important in determining their respective pheasant populations.

The heavier use of commercial fertilizer on the Check Area corresponds to the larger pheasant population found there, but a definite cause-and-effect relationship is not apparent. Pheasants are generally associated with fertile soils (Nelson 1952), and some critical mineral that Amish farmers did not apply may be replaced by these fertilizers. Such a determination, however, was beyond the scope of this study. Spreading of animal manure on Amish Area fields may compensate for the smaller amounts of commercial fertilizer applied.

No apparent relationship can be found between agricultural chemicals and pheasant populations as a result of this study. The use of herbicides has been blamed for the loss of ground cover in cultivated fields (Klonglan 1971). Similar types of herbicides and rates of application were used on both the Amish and Check Areas, however, and similar effects on cover conditions should have resulted. No farmers were observed spreading chemicals in any but cultivated fields on a regular basis. Insecticides were used so sparingly, and only on the Check Area, that no conclusions regarding its use can be drawn.

One other farming method not previously mentioned appears to be the primary cause for the absence of waste areas on the Amish Area. The drainage of wetlands, using both drainage ditches and tile drains, has occurred on both Areas. The extent to which wetlands covered the study areas prior to drainage is not known. All farmers on both Areas stated that their farms were tiled, but none could give a quantitative estimate of the extent. It seems likely that drainage has been less extensive on the Check Area, simply because more wet areas still exist. Topography and natural drainage patterns were superficially similar on both Areas (Fig. 2 and Fig. 3). Amish farmers are not handicapped in installing tile, because they rent modern trenching machinery for this purpose. One Amish farmer stated that most of his land had once been a slough, but drainage had allowed him to put it all into production. One non-Amish farmer who had lived on the same farm for 60 years claimed that pheasants had once been abundant in the vicinity, but drainage of sloughs had removed all cover. Similar opinions were shared by all of the long-time residents of the Amish Area. Thus, it appears extensive drainage activities and intensive use of the remaining wet areas as pasture are the critical factors affecting pheasant cover on the Amish Area.

Modern Agriculture versus "The Good Old Days"

Modern agricultural practices have long been blamed for the pheasant decline experienced in many areas throughout the Midwest in the past 30 years. The change from horse farming to mechanized agriculture, and its associated effects on pheasant cover, has been cited by many authors as the cause of the pheasant decline. Macmullan (1961) states that intensive agriculture has generally led to a decline in good pheasant nesting and winter cover. Nomsen (1969) feels the trend to larger farms had been detrimental, due to the loss of windbreaks and fencerows. Faber (1948) found a correlation between declining pheasant populations in Iowa from 1938-48 and the loss of undisturbed cover as the prices for corn and soybeans increased. More machinery has allowed farmers to plant greater acreages of row crops, decreased hay and oats acreages and allowed greater drainage of wetlands (Dalziel 1967 and Bishop 1968). All of these aspects of modern agriculture are well known, and their effects seem obvious. This study, however, indicates that all aspects of farming in the horse and buggy days were not favorable for pheasants.

The Amish Area seems to be typical of what the authors cited above claimed were peak pheasant-producing conditions. Smaller farms, more fencerows, more leisurely field activities, greater acreages of forage crops and less land under cultivation were found on Amish farms than on the Check Area. Yet pheasants were extremely rare on the Amish Area. The one factor not accounted for by most critics of modern agriculture is the presence of larger numbers of livestock in the past. Amish cattle and horses grazed off nearly all available pheasant cover not found in hay and oat fields. Fencerows in many places looked like poles set in a bluegrass lawn. The few remaining wet areas had been trampled and grazed to the extent that no pheasant cover remained. Similar areas on the Check Area, where grazing was at a minimum, provided excellent cover. This is not to say that conditions similar to the Amish Area existed everywhere prior to the introduction of modern farm equipment. The Old Order Amish probably represent an extreme case, where intensive farming is required to support their families on increasingly smaller farms (Center for the Biology of Natural Systems 1972). Grazing must have had an effect on pheasant cover in some areas in the past, however, and care must be exercised in assuming the change to modern farming methods has been all bad for the pheasant. More long-term studies on the effects of land use changes on pheasant populations seem necessary before such conclusions can be confirmed.

SUMMARY

1. This study, conducted in 1968 and 1970-71, was initiated to compare pheasant populations, nesting and production on two areas where old and modern styles of agriculture predominate; and to relate differences or similarities to land use, farming methods, or use or non-use of agricultural chemicals to pheasant numbers.

2. Two study areas were established in northeast Iowa - an area inhabited by a colony of Old Order Amish farmers, and a nearby designated Check Area occupied by modern farmers.

3. The Amish farmers still use horses for field work, shock and thresh oats, husk corn by hand and do not use government land retirement programs. Nearby Check Area farmers use modern farming techniques and are fully automated in their field operations.

4. Amish farms averaged only 105 acres (50 percent smaller than Check Area farms) and required 34 miles of fences (10.6 miles per section) to keep livestock out of crops, compared to 14 miles (5 miles per section) on modern farms. All but 1 mile of Amish fencerows was bare of concealing vegetation, while 8 miles had enough vegetation to provide some cover on the Check Area.

5. Similar crops were grown on both Areas, but Amish farmers devoted land mostly to oats, hay, pasture and corn (Totaling 85 percent of the 2040-acre Area). Check Area

farmers raised mostly cash crops (corn and soybeans), totaling 75 percent of the 1776-acre Area.

6. Cultivated land comprised 90 percent of the Check Area, about 10 percent more than on the Amish Area. Waste areas constituted the largest portion of uncultivated land on the Check Area, averaging 35 percent for 1968 and 1971. Permanent pasture totalled nearly 60 percent of the uncultivated land on the Amish Area.

7. Potential pheasant nesting cover (hay, oats, diverted acres, waste areas and road ditches) comprised 28 percent of the Amish Area and 21 percent of the Check Area, but undisturbed cover in road ditches and waste areas totalled only 3 percent and 6 percent, respectively. Grazing by livestock reduced the quality of waste areas on the Amish Area, but Check Area farmers did not pasture waste land.

8. Three times more winter cover (105 acres) was found on the Check Area, 75 percent of which was in waste areas (sloughs, waterways and odd corners). Suitable winter cover totalled only 40 acres on the Amish Area.

9. Amish farmers have continued to use traditional crop rotations, while modern farmers have switched to continuous cropping methods. Amish farmers used crop rotations of 3, 4 or 5 years, while only 2 of 10 Check Area farmers still rotate crops.

10. The average application of starter fertilizer used on the Amish Area was 132 lb. per acre, compared to 200 lb.

per acre on the Check Area. Anhydrous ammonia was applied to only 58 acres of corn on the Amish Area, averaging 20 lb. per acre for all corn fields, compared to 150 lb. per acre applied to Check Area corn fields.

11. All farmers on both study areas applied chemical herbicides to corn and soybeans, with similar average application rates used on both Areas. Amish and Check Area farmers applied about 2.5 lb. of herbicide per acre, but total applications used on the Check Area were greater due to the larger corn and soybean acreage found there.

12. No Amish farmers, and only two Check Area farmers, reported the use of any insecticide in the past 6 years. Dyfonate, an organophosphate, was used on two Check Area fields in 1971.

13. Harvest chronologies for hay and oats in 1968 lagged 3 weeks or more behind those found in 1971, primarily due to rainy weather in 1968. Under normal weather conditions, hay mowing appeared to coincide on both Areas, while harvesting of oats occurred 1 week earlier on the Amish Area.

14. Corn harvesting proceeded at the same rate on both Areas in 1971, but wet fields in 1968 allowed Amish farmers, using only horses and wagons, to harvest 38 percent more corn by the opening week-end of pheasant hunting season (mid-November).

15. Nearly 10 times more waste corn was left in Check Area fields following the harvest in 1968, and 3 times more

was left in 1971. On a sample basis, about 37 and 119 ears were left on the Amish Area fields in 1968 and 1971, respectively, compared to 339 and 357 ears left in Check Area fields.

16. Fall plowing was more common on the Check Areas in both years, occurring on 15 and 31 percent of the entire Area, compared to only 10 and 5 percent of the Amish Area.

17. Roadside counts revealed that about the same number of pheasants were sighted per mile on both routes in 1968 (0.06 on the Amish route and 0.15 on the Check route), but 195 times more birds were seen per mile on the Check route in 1971 (0.02 on the Amish route and 3.9 on the Check route).

18. No broods were observed on the Amish route in either year, or on the Check route in 1968, but 17 broods (totaling 142 chicks) were seen on the Check route in 1971. Six broods (40 chicks) were seen during other field activities on the Check Area in 1968. Mean brood sizes were 6.7 and 8.4 chicks per brood in 1968 and 1971, respectively.

19. Hatching chronologies determined by back-dating from the estimated ages of chicks observed during roadside counts and field observations indicated that the peak of the limited hatch occurred in early June in 1968 and early July in 1971. A cloudburst on July 17, 1968, which apparently destroyed chicks and nests, may have prevented the appearance of broods later that summer. Therefore, the peak of the hatch appeared to precede that for 1971 by 3 weeks, when they may actually have occurred at nearly the same time.

20. Hunter interviews conducted during the opening weekend of pheasant hunting season in 1968, 1970 and 1971 indicated that the number of birds harvested on the Check Area increased during this period, while the effort expended per bird harvested decreased. One pheasant was harvested in 1968, 6 in 1970 and 25 in 1971. The number of birds bagged per gun-hour expended increased from 0.01 to 0.6 during the same period, and the gun-hours expended per bird decreased from 90.3 to 1.6.

21. Hunting parties were observed on the Amish Area only in 1970, and no pheasants were known to have been harvested in any of the 3 years hunters were interviewed.

22. Winter censuses produced only 14 pheasants (5 birds per section) on the Amish Area in 1971 and 10 pheasants (4 birds per section) in 1972, compared to 24 pheasants (7 birds per section) and 121 pheasants (38 birds per section) on the Check Area. Mild weather during the 1971 Check Area census probably caused fewer birds to be seen than were actually present.

23. Waste areas provided the most heavily utilized pheasant winter cover on the Check Area in both years, while Amish Area pheasants were concentrated in one drainage ditch. Check Area pheasants utilized 73 percent of the available winter cover in 1972 (the 1971 percentage was not estimated), while 85 and 20 percent were used on the Amish Area in 1971 and 1972.

24. Sex ratios of less than 2 hens per cock were found on the Amish Area in both years, reflecting the apparently small harvest of cocks on this Area. Ratios of 1.9 and 4.1 hens per cock were found on the Check Area in 1971 and 1972, indicating that more cocks were harvested in 1971.

25. Nearly 90 percent fewer cock-calls were heard on the Amish route (1.7 per stop) than on the Check route (14.9 per stop) in 1971, the only year spring crowing-cocks counts were made.

26. About 500 acres of potential pheasant nesting cover were searched in each summer, but only 4 nests were found in 1968 and 8 in 1971. Hay fields appeared to be the preferred nesting cover on the Amish Area. Six hay fields nests were found, one-third of which were successful and one-half of which were destroyed by mowing. A nest success of 43 percent was indicated for all Amish Area nests. Four of five Check Area nests were successful.

27. Nesting densities of 5 nests per 100 acres were found in Amish Area hay fields, 2 nests per 100 acres were found in oat fields on both Areas, and 10 nests per 100 acres were located in waste areas on the Check Area.

28. Average clutch size, fertility and hatchability rates appeared normal in the new nests found.

29. Wet ditch bottoms appeared to discourage road ditch nesting on the Amish Area (90 percent of the 1/10-mile segments searched were wet in 1968 and 67 percent in 1971), and

sparse bluegrass vegetation (found in 53 and 35 percent of the segments) probably made most of the dry segments unsuitable. Check Area segments were also wetter in 1968 (67 percent of all segments) than in 1971 (39 percent), but were dryer than Amish Area ditches and had fewer segments in bluegrass (23 and 26 percent) in both years. No explanation was found for the complete lack of road ditch nesting on both Areas.

30. The large increase in Check Area populations from 1968 to 1971 may be partially caused by an increase in undisturbed cover. A cloudburst in 1968, however, is thought to have destroyed production in that year, and was the major cause for the small number of pheasants observed. Populations in 1971 are believed to be more typical of the normal situation.

31. The lack of permanent ungrazed cover on the Amish Area seems to be the major limiting factor on Amish Area pheasant populations. Pheasants are forced to nest in hay and oats and nest destruction is high. These areas are also unsuitable for winter cover, but it is uncertain which factor is more important in limiting populations. Pheasants on the Check Area have more suitable cover in waste areas, and use them for both nesting and winter cover.

33. Hand-husking of corn, used only by Amish farmers, may contribute to the low pheasant populations found on the Amish Area, but is not as important as land use practices.

34. Commercial fertilizers were more extensively used on the Check Area.

35. No conclusions can be drawn about the effects of agricultural herbicides on pheasants as a result of this study, since similar types and rates of application were used on both Areas. Insecticides were used too sparingly to have a major effect on pheasant populations.

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APPENDIX I. LIST OF BIRDS AND MAMMALS

Nomenclature based on American Ornithologist's Union (1957) and Miller and Kellogg (1955).

Mammals	
Cow	Bos taurus
Horse	Equus caballus
Domestic dog	Canus familiarus
Domestic cat	Felis catus
Striped skunk	Mephitis mephitis
Red fox	Vulpes fulva
Opossum	Didelphis marsupialis
Raccoon	Procyon lotor
Badger	Taxidea taxus
Fox squirrel	Sciurus niger
Cottontail rabbit	Sylvilagus floridanus
White-tailed jackrabbit	Lepus townsendi
Pocket gopher	Geomys bursarius
Franklin's ground squirrel	Citellus franklini
White-tailed deer	Odocoileus virginianus

Birds	
Red-tailed hawk	Buteo jamaicensis
Marsh hawk	Circus cyaneus hudsonicus
Rough-legged hawk[a]	Buteo lagopus
Screech owl	Otis asio
Barn owl	Tyto alba prattincola
Blue-winged teal[b]	Anas discors
Mourning dove	Zenaidura macroura
Common crow	Corvus brachyrhynchos
Bobwhite quail	Colinus virginianus
Killdeer	Charadrius vociferus
Upland plover[b]	Bartramia longicauda
Belted kingfisher[b]	Magaceryle alcyon
Eastern kingbird	Tyrannus tyrannus

[a] Observed on the Check Area only.

[b] Observed on the Amish Area only.

APPENDIX I. (Continued)

Birds	
Horned lark[b]	Eremophila alpestris
Rough-winged swallow[b]	Stelgidopteryx ruficollis
Barn swallow	Hirundo rustica
Cliff swallow[b]	Petrochelidon pyrrhonota
Blue jay	Cyanocitta cristata
Brown thrasher	Toxostoma rufum
Robin	Turdus migratorius
Starling	Sturnus vulgaris
Yellowthroat	Geothlypis trichas
House sparrow	Passer domesticus
Bobolink	Dolichonyx oryzivorous
Eastern meadowlark	Sturnella magna
Western meadowlark	Sturnella neglecta
Red-winged blackbird	Agelaius pheoniceus
Baltimore oriole[b]	Icterus galbula
Common grackle	Quiscalus quiscula
Brown-headed cowbird	Molothrus ater
Dickcissel	Spiza americana
Savannah sparrow[b]	Passerculus sandwichensis
Vesper sparrow	Poecetes gramineus
Lark sparrow[b]	Chondestes grammaeus
Field sparrow	Spizella pusilla
Song sparrow[a]	Melospiza melodius
White-crowned sparrow	Zonotricha leucophrys
Fox sparrow[a]	Passerella iliaca
Yellow-shafted flicker[a]	Colaptes auratus
House wren[a]	Troglodytes aedon
Cardinal[a]	Richmondena cardinalis
American goldfinch[a]	Spinus tristis

APPENDIX II. LIST OF PLANTS

Nomenclature based on Fernald (1950)

Alfalfa	*Medicago sativa*
Red clover	*Trifolium pratense*
Oats	*Avena sativa*
Corn	*Zea mays*
Soybeans	*Glycine max*
Bluegrass	*Poa pratensis*
Brome spp.	*Bromus* spp.
Reed canary grass	*Phalaris arundinacea*
Slough grass	*Spartina pectinata*
Plum spp.	*Prunus* spp.
Willow spp.	*Salix* spp.

APPENDIX III. DESCRIPTION OF CHEMICAL HERBICIDES AND INSECTICIDES USED BY AMISH AND CHECK AREA FARMERS (From Midwest Farm Handbook 1969, Thomsom 1964 and 1970).

Chemical	Description
Herbicides	
Atrazene	A non-selective triazene herbicide used pre-emergence and early post-emergence on corn and soybeans to control annual broad-leaved and grassy weeds (foxtail, jimson, lambsquarter, ragweed, wild oats and many others). Application rates vary from 1-4 lbs./acre in 10-12 gallons of water. Requires moisture for activation, but is insoluble and may have residual effects if soybeans or oats follow in rotation. No reported effects on wildlife.
Atrazene + oil	Same effects as atrazine alone, but oil allows lighter applications and reduces residue problems.
Atrazine + Sutan	Combination allows lighter applications, reduces atrazene residue problems and controls a wider spectrum of weeds than either herbicide does alone.
Amiben	A benzoic acid used as a selective pre-emergent herbicide on corn and soybeans to control some annual and broadleaved weeds (crabgrass, foxtail, lambsquarter, pigweed, ragweed, smartweed and others). Requires moisture for activation, but leaves no residue. Applications range from 1-4 lbs./acre, but cannot exceed 2 lbs./acre on corn without damaging the crop. Livestock should be kept off of treated areas.
2,4-D	A phenoxyacetic acid used as a selective post-emergent herbicide on corn and grain crops to control broadleaved weeds without damaging grasses (toxic to thistles, golden rod, pigweed, plantain, willows, sunflowers and others). Applied at 1/4-4 lbs./acre in 40-100 gallons of water. Requires dew or light rain to activate, leaves no residue and does not accumulate in the soil.

APPENDIX III. (Continued)

Chemical	Description
2,4-D (continued)	One of the oldest herbicides, but no longer in common use. Not harmful to wildlife.
Treflan	A toluidine compound used as a selective pre-emergence herbicide to control annual grasses in soybean and vegetable crops. Applied at 3/4-1 lb./acre in 10-40 gallons of water and incorporated immediately into the soil. Does not require moisture and is resistant to leaching, but has no residual effects. Not harmful to wildlife.
Randox	A selective acetamide used pre-plant or pre-emergent on corn, soybeans and vegetables to control grassy weeds (bluegrass, cheat, crabgrass, wild oats and others). Highly irritating to the skin and relatively unpopular. Applied at 4-6 lbs./acre in 8 gallons of water and requires moisture for activation. Most effective in wet soils. Not harmful to wildlife.
Insecticides	
Dyfonate	A selective organophosphate used on corn and vegetable plants to control root worms and maggots. Applied at 2-4 lbs./acre prior to planting and incorporated into the soil. Works on contact, with or without moisture. No apparent residual effects. Hazardous to wildlife, and may kill birds feeding on treated areas.

APPENDIX IV. HARVEST CHRONOLOGY FOR HAY AND OATS, 1968

Date	Amish Area Acres harvested	Amish Area Acres unharvested	Check Area Acres harvested	Check Area Acres unharvested
		Hay		
June 7-9				
10-12				
13-15	0.0	196.7	-	-
16-18	19.9	176.8	0.0	68.1
19-21	57.2	119.6	12.5	55.6
22-24	39.3	80.3	-	-
25-57	60.9	19.4	-	-
28-30	-	-	22.0	33.6
July 1-3	-	-	10.0	23.6
4-6	19.4	0.0	-	-
7-9	-	-	11.0	12.6
10-12	-	-	-	-
13-15	-	-	12.6	0.0
		Oats		
16-18	0.0	285.2	-	-
19-21	170.3	141.9	-	-
22-24	25.4	116.5	-	-
25-27	-	-	0.0	145.1
28-31	-	-	14.1	131.1
Aug. 1-3	39.1	77.4	20.0	111.1
4-6	33.2	44.2	12.6	98.5
7-9	-	-	-	-
10-12	-	-	15.1	83.4
13-15	-	-	14.7	68.7
16-18	-	-	-	-
19-21	13.2	31.0	12.9	55.8
22-24	-	-	30.7	25.1
25-27	-	-	25.1	0.0
28-31	31.0	0.0		

APPENDIX V. HARVEST CHRONOLOGY FOR HAY AND OATS, 1971

Date	Amish Area Acres harvested	Amish Area Acres unharvested	Check Area Acres harvested	Check Area Acres unharvested
		Hay		
June 7-9	0.0	157.3	0.0	51.8
10-12	18.7	138.6	11.0	40.8
13-15	9.8	128.8	-	-
16-18	25.5	103.3	8.5	32.3
19-21	9.6	93.7	-	-
22-24	12.0	81.7	-	-
25-27	15.1	66.6	-	-
28-30	10.0	56.6	20.8	11.5
July 1-3	23.0	33.6	-	-
4-6	13.6	20.0	8.5	3.0
7-9	-	-	3.0	0.0
10-12	20.0	0.0	-	-
		Oats		
13-15	79.0	206.1	-	-
16-18	133.4	72.7	0.0	101.6
19-21	14.8	57.9	7.6	94.0
22-24	17.4	42.5	56.4	37.6
25-27	13.2	27.3	34.1	3.5
28-31	27.3	0.0	3.5	0.0