

DEVELOPMENTS IN DUTCH FARM MECHANIZATION: PAST AND FUTURE

by Ir. F. Coolman, Thysselaan 62, 6705 AS Wageningen, the Netherlands

1. Introduction

This contribution is based on the personal experiences of the author as a typical crop farmer in Holland in 1925-1991, as a researcher at the Dutch Institute of Agricultural Engineering (1954-1964), and as the Director of that Institute in the period 1964-1983. In essence, the 20th century developments in mechanized agriculture are considered from a historical perspective. The future of farm mechanization is discussed as affected by of recent technological developments.

The paper leads off with a general description of the step-by-step technical developments in farming in the Netherlands in the last 100 years. Hand-work, and horse-drawn implements and machinery, were still prevalent at the start of the 20th century. The use of tractors became commonplace only after the Second World War. Introduction of more technical applications came only after the seventies; this development will be described in the second part of the paper. A description will also be given of possible future developments regarding precision, durability and automation of farm machinery, and of the restrictions to which farmers and their family members are subjected. The paper ends with some general remarks on the future of farm mechanization in Holland.

2. Dutch Agriculture at the Beginning of the 20th Century

Early 20th century Dutch agriculture can be divided into a number of farm types:

- sandy-soil, mixed-type small (sometimes very small) family farms with arable land, and some dairy cattle, pigs, hogs and poultry.
- wet-soil (sand, peat or clay) family-type small dairy farms with a 8-15 cows.
- clay-soil medium-sized farms (mostly reclaimed from the sea in earlier centuries) with arable land and a small number of dairy cows. [A stable source of manure was necessary for fertilizing the arable crops and the grassland; soil fertility was the most important input for acceptable crop yields and a positive economical result.]
- clay-soil large farms (located in recently from the sea reclaimed “polder” land). [These farms had paid laborers and horse-drawn machines and implements.
- open-air and glass-covered small acreage horticultural farms, mostly located close to large cities. [These enterprises specialized on a small acreage in certain crops, e.g., table grapes).]

Mechanization with horse-drawn equipment was not yet common on the small farms. Nearly all

the work had to be done with hand tools (only occasionally with simple horse-drawn tillage implements). Simple hoeing implements had already been developed, quite often locally. On the large clay-soil farms, the first steam-driven threshing machines could be seen because of the larger amounts of cereals grown overthere. In the areas with large farms, contractors supplied the threshing while the cereals on smaller farms were still threshed by hand.

The first agricultural education was started in Holland in 1866. [My father took his first courses in 1905 and 1906.]

3. 1914-1935 Agricultural Developments

By 1914 improved horse-drawn implements had become available as well as farm trailers. The first threshing machines, driven by small engines, became available for small cereal farms (contract work); on grassland farms hay rakes and tedders appeared. Also, the first fertilizers were introduced on experimental and demonstration plots. The Wageningen Agricultural College had been founded in 1876 and acted as a center of knowledge in the agricultural sciences.

After the First World War, Dutch agriculture prospered. High prices for a number of products, especially cereals, encouraged investments in mechanization. The first large tractors were imported, especially on the large arable farms in the new polders in the former Zuidersea (today the Ysselake, created by a closure dam in 1932). The first polder (established in 1928) was called the Wieringermeer; the average farm size was 55 hectare and thus allowed “modern farming”. The first reaper-binders became available in the early twenties.[My father bought in 1926 a model which had to be pulled by three horses; they could do the work for a maximum of three hours. A few years later, he bought a new reaper equipped with a 4 HP gasoline engine.] High-voltage electricity was installed in the mid 1920s which allowed the grinding of cereals for the animals and the operation of hoists for lifting sheaves in the barn for storage before winter threshing.

Soon the threshing machines became larger and more efficient. Steam power was replaced by tractor power. The horse-drawn farm trailer still constituted the main link between the fields and the farm. The loading of the sheaves on wagons with grain forks remained handwork.

Holland has significant areas of peat soils on which industrial-type potatoes grow well (they were mainly processed into potato flour). In 1924, a local technician developed the first potato harvester; the design was the forerunner of the modern potato harvester.

On dairy farms, the cutter bar mower soon became the most important implement in haymaking. Horse-drawn tedders and rakes followed the cutterbar. A new overtop tedder shortened the field-drying period a very welcome character trait in the rainy Dutch sea climate. Grass silage was hardly known in those years although the first experiments were conducted in that period. Milking was still done by hand by the family members or hired labor.

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In horticulture, progress came through the increase in yields and in the improvement of greenhouse design. Most work was still done with hand tools and simple technical aids. Rough climate-control in greenhouses became feasible, and as a result many horticultural enterprises enlarged to take advantage of the changed economic conditions.

As a forerunner of mechanization, the first land-improvement projects were started. This became a major item in later years through the development of projects on land reallocation, farm enlargement, water control and traffic regulation; they formed the basis for modernizing of agricultural production, especially on small farms on sandy soils. Breeding of new varieties, and spraying against the potato blight, raised yields in this period. Education in several newly-established agricultural community colleges provided farmers with the newest scientific knowledge.

Tractors came into use in this period. On the larger farms, these were models driven by gasoline or diesel engines. [Gasoline was at that time not expensive.] Since cars in that time had gasoline engines, some local mechanics changed used cars into so called "car-tractors" by removing the cab and installing a low-gear transmission; besides, the rear wheel size was enlarged and provided with tires which had more grip on the soil. By 1935 over 500 car-tractors were operating on crop and dairy farms—most already equipped with a side-mounted cutter bars. The purchase price of car-tractor was less than 50% of that of a new 24 HP tractor with iron wheels. The gas price in that period was less than that of a kg of wheat or a liter of milk.

4. 1935-1945 Developments

The 1935-1945 period is influenced by two international events: the world economical crises and the Second World War. Dutch agriculture struggled in the thirties with low commodity prices, and after 1940 with foreign occupation. Until 1940, the government continued its land reform program and its financial and social support to farmers. Small industries offered additional employment, especially in areas with small farms on which families lived with (often) more than two children. This resulted in extra family income which allowed investment in new cheaply-built chicken and swine houses. Much work was still done with handtools.

On the larger dairy farms, the number of cows increased because of additional feed available through better use of fertilizers. The demand for improved haymaking machinery grew, in particular for locally-manufactured (and imported) tedders, swath turners and side-delivery rakes. Hay remained the main feed. However, silage production with the aid of additives started to become popular.

The arable-land farms, mostly large in size, became more mechanized. Minimizing of the labor requirements was seen as essential. The reaper-binders had a wider cut and were more often driven by small petrol engines. Sheaves were stacked in the barn with the aid of petrol- or electrical-driven elevators. Potatoes harvesters delivered the crop on the top of the soil. Reaping required 200 man-hours per ha while the harvesting by hand had demanded 450 man-hours. The harvest of sugar beets was still mainly handwork. For tillage and plowing, tractors replaced horses. A common rule was that a tractor was economical if it could do the work of four horses.

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This was the case for only the larger farms because for transport of products from the field to the farm required at least four horses. Since farms with eight horses or more (above 50 ha) were rather scarce, the number of tractors remained low. The first combine-harvester imported in Holland was not a success because the Dutch cereal varieties in use at that time were not suitable for combine harvesting.

The number of small stationary machines on farms increased slightly during this period. Electricity presented new opportunities, and contractors with engine-driven tools offered additional services. Threshing, baling, and on-farm preparation of feeds became common activities even on small farms. Education on the new developments was supported with practical demonstrations.

New government research stations guided the developments in greenhouses. Improved knowledge of plant requirements led to better climate control for the increasing number of crops (fruits, vegetables, flowers, pot plants). The first regions with multiple glass-covered greenhouses appeared.

The Second World War stopped new developments in agricultural mechanization in the Netherlands. Since a large number of horses were requisitioned by the occupier, farmers and farm organizations had to improvise to maintain the agricultural production. Products formerly imported also had to be replaced. The main object of Dutch agriculture during the war was to supply the basic food needs of the nation. Technical progress was very limited. A small number of tractors were modified with wood generators because regular fuels were no longer available to agriculture.

5. 1945 – 1960 Development

The period after the Second World War can be characterized as an era of many new developments in farming. The Marshall Plan Aid provided the momentum for rapid mechanization of agriculture through the use of additional tractors and farm machinery. The European industry rebuilt rapidly; especially the farm machinery industry which started to produce diesel-powered tractors in a period that American tractors still started on gasoline and ran on kerosene.

Several farm implement companies were founded in this period; most developed from simple blacksmith shops and produced tillage implements, ploughs, and haymaking equipment. The three point linkage was one of the revolutionary developments as was the p.t.o. for the cutterbar and the drum mower. New fertilizer spreaders replaced the horse-drawn types. The number of horses in agriculture, already considerably diminished during the occupation, decreased further. An important question for small farmers was to decide on which farm size it would become economical to change from horses to tractors? The author's own research (1954 - 1958) showed that even on a farm as small as 6 ha a tractor was justified, if the hours saved were used for expanding production. More intense farming by adding, for instance, chickens or pigs to the

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enterprise, resulted in higher production and a larger income. More efficient use of grassland (e.g., better fertilizing and cutting/grazing systems) allowed more dairy cows per hectare. Open-air horticulture (labor intensive but with high commodity prices) resulted in higher incomes also for family members on small farms.

On the arable farms, larger tractors and implements became a common sight as horses disappeared. Small tractors performed the lighter tasks such as hoeing and transporting, and the larger models did the tilling and plowing. Four-wheel farm trailers had rubber tires as were the new two-wheeled self-unloading models. The wagon-load capacity increased from about two tons to 5 or 6. Contract harvesters started to employ heavy equipment such as self-propelled combines and one-row and (later) two-row sugarbeet-digging equipment. On the loam/sandy soils potato harvesters were introduced which delivered the product directly on a self-unloading trailer.

On arable and on dairy farms contractors and machine cooperatives began to play a larger role. The new harvesting machinery had a large capacity and easily could serve a number of farms. Besides, the equipment was so expensive that few farmers could afford to own it outright. Shared usage of machinery was already popular in Holland. For instance, my father's threshing cooperative of 13 farmers bought in the fifties a sprayer which had a working width of 16 meter and could treat crops with insecticides, fungicides or weed killers in only a few hours. It should be noted that one of the members in the cooperative had special knowledge of the use of pesticides.

In this period, revolutionary development occurred in the dairy industry. Dairy farms became larger, milking machines replaced hand milking, silage was added to the feed, and horses disappeared being replaced by tractors. Contractors offered grass-chopper resulting in better silage. The first milking parlors were built. Slatted floors became known.

Government funds became available for new buildings and small concrete silos. The government even set up some demonstration farms where new agricultural equipment was shown to the general farming community.

In horticulture, two-wheel tractors and small four-wheel tractors were introduced. Horticultural crops not grown in greenhouses but on large farms were often grown under contract with a canning factory. In those cases, the factory took care of the harvest.

The small horticultural growers employed usually the smallest technical aids for tillage and transport; for spraying, dusting and harvesting hand tools were still used. In greenhouses, much attention was paid to climate control in order to optimize the output per plant. Much of the horticultural production went for export.

Orchard mechanization required middle sized tractors for spraying, transport, tillage and cutting the grass under the trees. Picking aids came somewhat later.

Work simplification, time studies and work planning became new concepts in research and in practice. Labor and machinery costs became major items in farm planning and farm economics.

Saving labor costs and minimizing physical requirements became important goals of the agricultural scientist and the average farmer. Therefore, sacks of 100 kg disappeared because sacks of only maximum 50 kg were still legally allowed. [Today, the Dutch Health and Safety Law prescribes the maximum weight of a sack to be 25 kg.]

Education underwent a change in lecturing, planning and management; it had to get acquainted with a combination of new technical tools and practices. Agricultural colleges and experimental farms assisted the Advisory Service in providing the necessary practical training courses for keeping the farming community properly trained.

In conclusion, it can be said that in the Netherlands the after-war period can be seen as a time of rapidly increasing production of agricultural products. Under a rather favorable pricing setting, a sound economical base had been created for further growth. The use of tractors, harvesting machinery, and other modern equipment lead to an increase of production with the help of fewer workers. Horses were now only used for pleasure, the number of paid laborers had decreased substantially, and the average farm income grew. The number of farms began to decrease; the average farm size was becoming larger. A new age in agriculture was knocking on the door. Land reform programs were necessary to bring about this development.

6. 1960 – 1980 Boom Developments

During the second period after the Second World War, precision- and quality-agriculture were truly introduced in the Netherlands. New technical and electronic applications became possible; e.g., "knowing what plants, soils and animals need". Cow identification and leaf sensors were the first applications. Automation and control of machines and installations are other examples.

Research became another important aspect. Fulfilling the needs of living material requires a multidisciplinary approach. Technical workers understand photoelectric cells, displays and sensors, but producing healthy food and fibers efficiently is quite another thing. .

New technical instrumentation made available significant information on equipment digital screens. Farmers and the machine operators became familiar with high-tech aids. Education and research guided them. Farms became high-tech enterprises.

This development went coincided with a growing of farm size and an increase in worker output. Large crop farms turned into family farms; cooperation with a close neighbor in machinery use became common because much farm machinery had enough capacity for two or three farms. Harvesting machines, especially potato and sugar beet harvesters, became larger. Potato harvesters became two-row machines, but four-row type with capacities of 1 ha per hour were also popular. The same development occurred with sugar beet harvesters—six-row harvesters with a working width of 3 meter came on the market

A new crop, chopped corn for silage, became popular for the feeding of dairy cattle on small

mixed-crop farms on sandy soils and on grassland farms. One-row side-mounted choppers, and self-propelled two-row and four-row choppers were introduced. The maximum working width was 3m because of the Dutch over-the-road traffic regulations. Many of the high-capacity harvesters were owned by contractors.

Farms continued to grow in size. For example, the farm size of the (in the in the forties reclaimed) North East polder, located in the old Zuiderzee (now called the Ysselmeer), was 24 ha while the two new Ysselmeer polders were 50 ha (and some even 75 ha).

In general, in many regions in Holland mechanization became concentrated on the larger farms. This is clear if one considers the size of the average tractor: in 1950 a 38 hp tractor was regarded large but in 1980 a 100 hp model was not even considered to be very big. The larger farms and fields justified a 4-bottom plough and other large tillage implements. The size of farm trailers increased from 4-5 tons to 10 tons or even more.

Another aspect of farm operation should be mentioned, namely the increase in yield per unit of production. By improving the growing conditions in the soil, by planting of new varieties, and by practicing better pest control, the winter wheat yields were raised from an average of 4 tons per ha before the Second World War to 8 or 9 tons. The same development occurred for potatoes: the yield increased from 25 to 50 tons per ha. [At present, 11 tons of wheat per ha is considered to be a good crop, and for potatoes 65 tons per ha.] The milk production per cow: rose from 4500 liter to 7000 liter. The increases in production were necessary to pay for the costs of mechanization and the fast-rising wages. Dutch agricultural policy was directed towards a reasonable income for the different types of farms by proper federal control of wage agreements, price supports and import duties.

A special development has to be mentioned separately. In some areas, some farmers started large swine and chicken farms, using imported concentrates as feed. This resulted in a large manure surplus and caused environmental problems in densely-populated Holland. Technical solutions to the manure-storage and the odor problems were developed to. Distribution of manure to crop and grass land became a challenge; the quality (content of elements) of the manure had to be determined in order to prevent an overdose of particular elements. Export of dry chicken manure (mainly to France) took place to eliminate the surplus.

In horticulture, especially in the tomato and cucumber sectors, modern technology made Holland into the garden of Western Europe. New production systems were developed by better controlling the growing systems. This was also true for flowers and pot plants. Worldwide export of these commodities resulted in becoming a very important export sector of the Netherlands in the next decades. The high level of technical expertise developed in the horticultural sector helped in developing similar export opportunities in dairy and meat products.

7. 1980 – 2000 Developments

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The developments in the 1980-2000 period bring us to the present. “ Robotization” of the milking parlor and computer-based control of tractors and combines were introduced rather recently. Computer programs using G.P.S. information were developed to optimize fertilizer and pesticide placement. Satellites offered also the possibility for more precise weather forecasting, an important item in the always changing (sea) climate in Holland. Thus, the farmer became better informed and the general management of his enterprise improved; also because he started to use computers himself. Although non-computer based labor- and farm-planning programs had already given him valuable assistance for managing his farm, computers allowed him to take more advanced educational courses and stay up to date with the latest technical developments.

Plant and animal breeding made much progress in this period. University research conducted at the well-known Agricultural University of Wageningen contributed greatly to improving the quality and yield of the crops and husbandry common in Holland. Although farmers benefited from these developments, the general public began to object due to some unintended consequences. The artificial treatment of living materials was regarded as unnatural. Also, many non-farmers regarded over-fertilization with high amounts of animal manure as dangerous for the public water supply. The objections by the general public began to affect the economics of farming.

The number of inhabitants in Holland increased from 3.5 million in 1910 to 16 million in 2000. In that period the export of agricultural products increased to just over 20 % of the total Dutch exports. It is also interesting to note that in the first decade of the 20th century about 25 % of the Dutch population was active in agricultural production. Today this number has decreased to 3.5 %, resulting in a serious loss in political power. Farmers now have to deal with environmental problems which (mostly) can only be solved by technical means. An example is the spray-free zones around fields and the special spray nozzles to prevent pesticides from reaching the water in the ditches. Also, new nozzle designs give a more uniform distribution of pesticides on the plant leaves so that farmers can apply less material and still get acceptable results against potato blight or other diseases. Precision weeding with photocells is used to keep crops clean without the employment of much weed killer. Sample analysis of liquid manure offers the possibility of precise application through the use of G.P.S. Photoelectric recognition of plants and their needs leads to further technical refinements. In all these developments, the agricultural engineer has played (in a multidisciplinary approach) a major part.

8. Future Developments and Sustainability

The last section of this paper contains a number of questions and short answers.

1. What is the meaning of sustainability?

Does it mean "lasting for ever"? Many claim that agricultural science has gone too far with its technical developments, and that the present level can not be sustained. Besides, many feel that

modern agriculture is often unnatural. They point to animals confined to small spaces, and plants developed by artificial means.

Whether sustainability in agriculture can be reached is not clear at this point. We can say with certainty that agriculture has made enormous progress in the past century and that the way of life of the average Dutchman is much improved food wise. Two questions remain: 1) if the present type of agriculture can be sustained, and (2) and if farming will remain an economically healthy enterprise in the Netherlands.

2. Is sustainability uneconomical?

Yes, farming will become uneconomical when farmers have return to “old-time” farming with horses and without high-yield crops. Using much less fertilizer and hardly any weed killer will raise the production costs to such a level that the consumers no longer will buy the products when also "normal" products are available. In Holland, many stores at present offer so-called “healthy” produce at a higher price. Few buyers select them because one can not see the difference in quality. Maybe this will change in future if it can be proven that the “ natural” way of production benefits both the farmer and the consumer.

3. Is sustainability a social value?

Many in Holland consider sustainability to be a social issue. Part of the responsibility of rural society is to keep the countryside attractive for the non-rural population. In densely-populated Holland this plays a significant role. Many farmers earn extra income by opening their farmstead to non-rural visitors as a form of recreation.

Another new aspect of farming which is becoming financially attractive is to keep the landscape appealing around the farmstead. In many areas it is expected of the farmer to enhance nature. Today, the Dutch government subsidizes the work necessary to keeping nature surrounding farms attractive and the farm buildings historically true.

4. Is gene manipulation acceptable?

First of all, gene manipulation is not new. In cross breeding, geneticist have played with genes for over a century. However, nobody knew where the genes were located in the chromosomes. Now we know where a resistance gene is located and to which resistance it contributes. Is it wrong to use this knowledge? In my opinion, it is not. But this item became a political and even religious subject, when animals first were manipulated in the nineties. It would go too far to go into detail, but it is very likely that manipulation will result in better plants and animals.

5. What can Agricultural Engineering offer in future?

The last decades of the past century have brought a number of new possibilities as described before. Chips, sensors, photo electric cells, and GPS will lead to more precision, automatic control and robotization. More and more we will raise moral questions. Together with other sciences, Agricultural Engineering will come closer to the optimal possibilities of sound production of basic material for human life. The wellbeing of mankind is at stake. The farm profitability will determine in how far new elements can be introduced. C.I.G.R. can be

expected to get a number of new tasks.

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