North America and Europe

CHAPTER 2

CHANGES IN AGRICULTURE AND FOOD PRODUCTION IN NAE SINCE 1945

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2.8.6 Changes in diet/consumption

2.8.7 Key changes in consumption systems

Key Messages

1. Following WWII rapid advances in the understanding of plant and animal biology fueled productivity increases and provided new tools for identifying and addressing agricultural problems. In this period, agricultural production and productivity increased significantly, especially in Western Europe and North America, but more slowly in Central and Eastern Europe. The increased productivity of agriculture was supported by technological development and food supply policies.

An increased range of technologies and tools has been available to agriculture primarily through advances in AKST. Farmers have accessed AKST to enhance crop and livestock productivity and quality. Efficient knowledge transfer systems developed in the governmental and private sectors have facilitated the dissemination of these new tools. Information technology (IT) has revolutionized AKST as well as food manufacturing, transportation and distribution and has allowed efficient dissemination of AKST.

The broad range of new technologies, some of them controversial, has had and is having significant impacts for all NAE societies. The impacts of scientific and technological advances have been and are being, felt in both conventional plant and animal breeding programs and those involving biotechnology. Biotechnology, including genetic engineering, has greatly expanded the speed at which traits critical to agriculture can be identified and manipulated.

Crop production has increased considerably over the last 50 years in the NAE particularly in output per unit area. These increases have been due to improved soil management, increased fertilizer use, including new synthetic fertilizers, greater technological sophistication and scale of agricultural mechanization and development of agrochemicals for pest and disease control. Wider adoption of irrigation coupled with the conversion of pasture to permanent cultivation has contributed to production increases. The development of plant breeding technologies, including hybrids and genetically engineered varieties, have changed the way most North American and Western European farmers obtain seed to annual purchases rather than saving seed. Uptake of genetic engineered crops has differed markedly in the region. They form a part of just a few cropping systems (predominantly soybeans and cotton, but also maize and canola) in North America.

Overall, livestock productivity and output in NAE has increased since 1945 with beef, pig meat and milk production almost doubling and a four-fold increase in numbers of poultry. This has been driven by increasing demand from a growing and wealthier population and by production-oriented policies. Increases in productivity are due to animal breeding developments, intensive rearing systems, antibiotic use and high-yielding pastures. Technical advances in fish breeding and rearing have led to considerable increases in production in both saltwater and freshwater fish farming.

NAE is the only region where there has been an increase in forest area since the 1960s, partly as a result of increased plantations and partly resulting from re-growth following abandonment of agricultural land. Demand for forest products in NAE has increased dramatically because of a larger and wealthier population. New management and processing technologies have been introduced to meet these demands resulting in increased efficiency and better access to remote areas. The environmental quality of forests in NAE has declined somewhat over the last 50 years. This has been caused by a variety of factors, including a significant increase in forest fires across NAE; it is a complex issue still not fully understood.

In North America and Western Europe, agricultural policies were adopted and implemented to improve farm income, to promote use of technology and to sustain productivity. In terms of increasing productivity and total production, these policies were largely successful. They also helped improve average farm income, ameliorated poverty in rural populations in some regions and contributed to overall economic development.

2. These increases in total food production addressed much of the problem of hunger and food shortages across NAE. The increase in food supply in NAE has progressively led to a greater availability of food both in quantity and variety and more recently to an overabundance of calories. Despite the absolute quantity of calories available, poor households across the region often do not have access to an adequate nutritious diet.

The increase in agricultural productivity has led to a decrease in real prices of agricultural products in North America and Western Europe over the last 40 years. This situation has led to more affordable food and ensured food security for the majority of the NAE population. Nevertheless, increased food availability and changes in human behavior and lifestyle have favored the development of nutrition-related chronic diseases. Over the last 15 years, these chronic diseases, including obesity, have had a heavy economic, public and social cost throughout the region.

In Eastern Europe and the Soviet Union, the degree of food self-sufficiency increased from the late 1940s until the 1970s; however, in the USSR, food and agricultural shortages from the 1960s to the 1980s led to increased agricultural imports. In the 1990s a transition period occurred in

Central and Eastern European countries characterized by falling output. Household allotments have been particularly important in the former Soviet Union and now Russia, for food security where small household producers account for 25-50%of agricultural output (e.g. potatoes, key vegetables and meats).

3. Knowledge systems used for breeding new plant and animal varieties and for agrochemicals have been partially protected as intellectual property and increasingly privatized. The emergence of technologies protected as intellectual property has created synergies that have favored industry consolidation and has facilitated the creation of NAE-based transnational agribusinesses. These transnationals now account for almost a third of commercial seeds worldwide and a significant share of livestock genetics.

4. The structure of the food system has changed with time in NAE. The agricultural and food system has become more vertically integrated from agricultural inputs to food retailing. Improved productivity and food security led to mature markets for staple food stuffs and limited the opportunities for further growth. Food suppliers responded by increased differentiation and food innovation. The largest actors, including large-scale food retailing and food catering/service businesses have increasing influence over the production of food. Food suppliers sought to expand the market initially by increasing the range of available foodstuffs through trade in ‘exotic' foods, through all-year round supply of fruits and vegetables, through the development of the processed food market and through the development of ‘quality' food products. Crop and livestock enterprises have become fewer and larger due to economies of scale; this trend is likely to continue. Changes in agricultural labor have been uneven across the region and across agricultural systems. The need for farm labor has generally decreased in conventional cropping and livestock system, but some farming systems, particularly fruit and vegetable production, have intensive demands for farm labor. Increases in sizes of farm and food processing entities have often led to reliance on immigrant labor.

5. Biofuels have always been a component of energy production in NAE, especially for heat, although biomass is generally less important as a fuel source in NAE than in other regions. In the past several years, biofuel production has dramatically increased in importance and application. Policy directives across much of the NAE have led to the subsidization of the use of biofuels to replace fossil fuels, which has spurred the production of bioethanol and biodiesel, mostly from maize and oilseed rape. There is active research to generate “second-generation” biofuels from other more energy-rich plant source materials, especially biomass.

6. The concerns over the application of new tools and technologies and the changed production systems resulting from them have contributed to a growing environmental, social and health awareness in NAE. Crop and livestock production in the NAE is among the most intensive in the world and this has had serious adverse impacts on the environment. Increased awareness of these adverse effects has resulted in regulatory frameworks for the use of agrochemicals, the use of new tools and technologies and the development of alternative production systems, including organic agriculture. This awareness has led to changes away from production-oriented policies toward those that are market-driven or environmentally led. The recognition of the multiple roles of agriculture has emerged in political and economic agendas.

In these agendas, agriculture is now seen as delivering not only food but services that meet emerging social demands such as environmental protection, (including the management of resources such as water and land, landscape, biodiversity and natural habitat); environmentally-friendly production of food; use of land for residential needs and recreational activities; protection of local cultures and knowledge; protection of cultural heritage through the production of traditional foods; ethical dimensions of food production such as positive contributions to food security and social justice (e.g. fair trade); and animal welfare considerations. These developments have been concurrent with an increasing demand for variety, including increased demand for foods that are high quality; locally produced; regionally specialized; organic; fairly traded; humanely produced; and ethnic.

The relative peace and stability in NAE has been an important component in securing food security.

2.1 Agriculture and Food System Specialization in NAE

In the past few decades agriculture in North America and Europe has gone through dramatic structural change. There has been a decrease in the number of farms, reduction in the agricultural labor force, increased specialization geographically and at the farm level and a loss of self-sufficiency at the farm level.

Technological change has been rapid in NAE and the introduction of any new agricultural technology has implications for markets, producers and consumers (Hayami and Ruttan, 1985; Kislev and Peterson, 1986). In most of NAE, technological change has favored capital intensive technologies and economies of scale. Mechanization has increased, generally allowing for larger average farm sizes although there is considerable heterogeneity in farm size and scale in NAE. Most NAE farmers have attempted a scale of operation characterized by the lowest cost per unit of output. The average unit cost follows an L-shape function; the unit cost at first decreases sharply with size but then reaches a plateau (Hall and Leveen, 1978; Nehring, 2005). The evidence for diseconomies of size is weak or non-existant. In spite of the fact that the average size of farms has increased in most of NAE, they are mainly managed by private farm families, most of which rely on off-farm income in addition to income from farming activities (Hoppe and Banker, 2005).

The decreasing number of farms, combined with increasing total output has led to concentration of production (Fig. 2-1). The number of farms necessary to produce a particular share of output has fallen; for example, from 1989 to 2003 the fraction of US farm production by large scale family and non-family farms increased from 57.7 to 72.8%). In Western Europe the farm size in terms of land area is only one tenth of that in the US; the number of farms is much higher but rapidly decreasing. From 1983 to 2001 the number of farms decreased in EU-12 from about 9 million to 6.5 million, but farms grew larger, especially in the livestock sector. A larger percentage of the farms in Europe compared to farms in North America operate on a part-time basis because of the smaller farm size.

Insert Figure 2.1. Change in farm size and number of farms in North America from 1940-2000

Economic growth also contributes to farm structure (Heady, 1962). Other things being equal, including the labor share of inputs, the scale of farm businesses must increase in proportion to the increase in non-farm labor earnings. The growth of other sectors of the economy has driven labor from agriculture to more productive sectors in most parts of the NAE.

Specialization, an important aspect of productivity growth in NAE agriculture, has improved the spatial organization of the food chain and lowered production and transportation costs (Chavas, 2001). In Western Europe and North America, specialization occurred largely because of economies of scale, larger economic forces and technological change. When economies of scale (the unit cost decreases with size) prevails over economies of scope (synergies between products and by-products), specialization increases which is followed by an increased size in production units. This leads to regional specialization and concentration. Government policies may also influence farm size and numbers. Agricultural policies after World War II directly promoted specialization through incentives (e.g. Pirog et al., 2001; for a fuller discussion of policies see 2.2). Yet larger trends have usually overshadowed the impact of policy programs on farm structure.

Farm specialization is particularly pronounced in North America (see Table 2-1) and in central and eastern European areas that experienced collectivization. Specialization differs by farm size with smaller farms the most likely to produce one commodity (Cash, 2002) (Figure 2-2). The average number of commodities produced per farm has fallen from 4.6 in 1945 to 1.3 in 2002 (Dimitri and Effland, 2005) even though financially successful farms have tended to be more diversified (Hoppe, 2001). Farms in the United States now have a bimodal distribution, with the number of farms in the middle declining (Duffy, 2003). More than 25% of very large family farms are specialized in hog and poultry and closely linked to processors (Hoppe and Korb, 2005).

Insert Table 2-1. 100 years of structural change in US agriculture

Insert Figure 2-2. Distribution of number of commodities by sales class 1999

Insert Figure 2-3. US farmland area (%) and total US farm production (%) by type of farm in 2005

While agricultural production is now highly concentrated in large farms, there still are a large number of more diverse small farms coexisting with a small number of very large farms that capture most of the markets for agricultural commodities (Miljkovic, 2005). Crop diversity declined between the 1930s and 1980s; the area sown to grain crops increased and woodland on farms declined (Medley et al., 1995). During this period the number of farms decreased by 60% and farm size increased from 37 ha in 1925 to 72 ha in 1987.

An examination of farm by type of ownership-operation provides a useful look at the diversity of farm types currently in the US Land is distributed fairly evenly among different types of farms, ranging from part-time farmers to very large scale operations (Figure 2-3). The large-scale, very-large-scale and non-family farms represent a disproportionately large fraction of the total US farm production (73% of the production from 38% of the farm area). Yet the majority of farms (98%) in the US as of 2003 are family-owned farms, though they may be organized as proprietorships, partnerships, or family corporations (Hoppe and Banker, 2006).

Specialization in the eastern part of NAE has followed a different path due to collectivization after World War II. The collectivization of agriculture was intended to exploit economies of scale, particularly in respect to mechanization and the use of agrichemicals. These were more obvious in large-scale crop production and possibly in intensive livestock production; they were less clearly applicable to farming in mountainous areas, or with labor-intensive crops. Collectivization led to the establishment of large collective or state farms which were highly mechanized and specialized but often inefficient in their use and allocation of resources. In the former Soviet Union the collectivized sector of agriculture (99.6% of agricultural producers were collectivized by 1955) grew significantly during the post-war decades (Matskevich, 1967). After World War II, the Central and Eastern Europe (CEE) countries were major suppliers of agricultural products to the Soviet Union. Compared to the more arid regions of the Soviet Union soils were relatively productive and a system of large collective farms was developed in the 1930s (Wheatcroft and Davies, 1994). This system was only economically viable under the centralized agricultural economies of the Socialist era.

As in the rest of NAE, the farm structure was dualistic in many CEE countries with numerous small self-subsistence plots and large-scale farms producing most of the gross output. Soviet agriculture essentially branched into two sectors. The collectivized sector was characterized by state-control, large-scale, reliance on off-farm inputs, mechanization and hired labor and centralized processing and distribution of outputs. This sector was capital intensive and emphasized the management of quantities rather than qualities, because of the lack of price signals for quality, whether judged by processing enterprises or final consumers (Sharashkin and Barham, 2005). Moreover, there was widespread use of agronomic and veterinary expertise (sometimes located within individual farms), which led to the provision of improved varieties of crops and livestock. Collectivized farms were linked to centralized input-supply and product-processing facilities. The other branch of Soviet agriculture was the household-managed sector, characterized by micro-scale, lack of state support or inputs, manual labor provided by the household and self-provisioning goals (Sharashkin and Barham, 2005). The latter was authorized by Soviet authorities at the beginning of WWII to fight impending food shortages and quickly spread throughout the country (Lovell, 2003). This household-based sector continued to grow and by the mid-1950s accounted for 25% of the country's agricultural output (Wadekin, 1973). Throughout the Socialist period, the authorities maintained an ambivalent attitude to household producers; their importance to food security was tacitly recognized, yet the government refrained from providing any support to household production so as not to encourage any "capitalistic", private ownership tendencies (Lovell, 2003).

Specialization was less pronounced in other parts of CEE. For instance, most farming production remained small-scale in Poland although some state farms were initiated when collectivization after 1956 affected the supply of inputs and crucially, the distribution of most output. Unlike Yugoslavia, where a similar semi-collectivization was enforced, the Polish government continued to exercise strenuous but erratic central control over agriculture in an effort to improve performance by balancing and linking the 85% of agriculture that was privatized with socialized sectors of farming. These efforts, which usually favored the larger-scale collectivized sector, were seldom successful and led to inefficient use of new technologies and inputs in this sector, while private producers were starved of both funds and technology and resultant stagnation.

After transition of the CEE countries to democracy in the early 1990s, the collective and State farm system rapidly broke down, partly because the system became uncompetitive when forced to compete in world markets and partly because the Soviet markets were no longer easily available to the transition countries. State farms were broken into smaller units and/or sold to private investors, which led to a rapid fall in agricultural output in many countries. Large farms remain a feature of many CEE countries, although many of these are now owned by corporations (Lerman et al., 2004). Production stabilized at the lower level but has started to recover in connection to the EU membership. In places like Russia, where household enterprises have been particularly important, small household producers produce nearly all vegetables and potatoes and over 50% of meat and milk products (O'Brien and Patsiorkovsky, 2006) (Table 2-2).

Insert Table 2-2. Agricultural output by product and enterprise in Russia

Privatization of agricultural land, as well as upstream and downstream parts of the agrifood chain, was largely completed by 2001, although it is very much an on-going process in some areas (e.g. Poland and Czech Republic). Land privatization has created a highly fragmented ownership structure across the region – less so in the Czech Republic and Hungary due to the restitution of land title exchangeable for investment vouchers or cash and more so in Bulgaria, Lithuania and Romania where the operational structure allows land to be farmed in large viable units. In Poland and Slovenia most of the land continues to be farmed as family type units as in the pre-transition period. The process of privatization has resulted in a bimodal structure in the region with both small and large scale farms especially important in Bulgaria, Estonia and Hungary. Large scale farms are dominant in Czech Republic and Slovakia and small and medium size farms in Latvia, Lithuania, Poland, Romania and Slovenia. In general, however, policies promote consolidation of holdings (OECD, 2001).

In Albania, the almost complete breakdown of the pre-existing system left the countryside open to fragmentation and a shift to household self-sufficiency in food. This process was evident in many CEE countries during the 1990s as a substantial proportion of the population, often older, newly unemployed and unskilled, retreated from the cities and towns to rural housing where an older, poorer but more secure way of life could be pursued.

Farm restructuring involved the reallocation of land, labor and capital and included organizational reform such as a move from cooperatives to family farms. In CEE there is now a wide range in the type of farm organization from family farms, private cooperatives, joint stock companies and part-time farmers. The restructuring has led to production efficiency gains but also contributed to the short term production declines seen in the early 1990s. Restructuring was complicated by conditions in the industry pre-reform including the type of farm organization, the degree of capital intensity, the extent of technology use and the degree and speed by which these initial conditions were reformed.

Crop production in the former crop production in the former USSR increased at about the same rate from 1961 to 1980 as world production. However, production levels remained stagnant in the 1980s, before falling about 30% in the 1990s to where production levels in 2000 were the same as in 1961 (Lerman et al., 2003).

2.1.1. Changes in farming and rural population in North America

In NA, the proportion of farm and rural populations as part of the total population has declined significantly since 1945 (Fig. 2-4). Mirroring these changes in population have been changes in the agricultural workforce. In 1945, 16% of the total labor force in the United States was employed in agriculture, but this dropped to 4% by 1970 and 1.9% by 2002 (Dmitri et al., 2005). Primary farm operators also begin to work more off-farm jobs during this time period. In 2002, 93% of farm households had off-farm income, a three-fold increase since 1945, when 27% of farmers worked off-farm (Table 2-1). The decade of the 1950s saw the largest exodus from farming (Lobao, 2000). During the “Farm Crisis,” 600,000 farmers exited farming between 1979 and 1985 (Heffernan and Heffernan, 1986); this exit particularly affected the economic base of rural communities in the Midwestern states.

Insert Figure 2-4. Change in rural and farm populations.

The shift in the relative percentage of urban to rural dwellers is often perceived as an exodus from rural areas, but during this time the total rural population has held relatively constant (Figure 2-5). It is important to look at the geographical consequences of changes in the farming population. For instance, farm size in the US heartland rose by 18% between 1980 and 2000 (Paul and Nehring, 2005). Similar strong growth in farm size occurred in the Lake and Northern Plains states but slower growth was evident in some other areas. Farming dependent counties were sprinkled throughout much of the US in 1950. By 2000, more than two-thirds of farming dependent counties were concentrated in the Great Plains of the United States, a giant swath in the middle of the country stretching from the Prairie Provinces of Canada to the panhandle of Texas (Barkema and Drabenstott, 1996; Dimitri et al., 2005).

Agricultural workers in NA. Since WWII the characteristics of hired farm labor supply have fluctuated widely both in North America and in Europe, with labor supply and demand being dependent on changes in farm structures, changes in consumer preferences, the growing power of retailers and the changing importance of the agricultural sector relative to other industrial sectors in the economies of NAE countries. The agricultural sector has been insulated from some of these changes because of its particular labor force structure, being largely dependent on farmer and farmer-family labor. It is estimated that 70% of the US agricultural production workforce in 2003 were farm operators, partners and their unpaid family members. Hired workers make up the remaining third of the workforce (Runyan, 2000; Vogel, 2003). Along with the variation of the size of the hired workforce among countries, there is also considerable variation between different sectors of agriculture and a concentration of demand for hired workers in vegetable, fruit and horticulture systems (Frances et al., 2005). The seasonality in these sub-sectors has encouraged the use of temporary workforces, but the nature of this workforce has itself been in flux for the last fifty years as conditions in the industry have changed. Temporary work in agriculture continues to require minimal skills and be physically demanding with poor pay and poor work conditions.

In the US this employment has traditionally been taken up by immigrant populations, which in the past have included Chinese, Japanese, Indian, Pakistani, Mexican and Dust Bowl migrants. The racial division between farm owners and farm workers has persisted; the 1997 US Census of Agriculture found 98% of US farmers were white and 1.5% Hispanic, but 90% of the hired farm workers were Hispanic (Martin, 2002). Hispanics living in rural areas are more likely to be working in lower skilled sectors such as agriculture and because of low wage levels are more likely to live in poverty than non-Hispanic whites (USDA/ERS, 2005).

Immigrant agricultural populations in the US have been regulated with varying levels of success by means of a number of laws, recruitment schemes and immigration policies including the Immigration Reform and Control Act (1986), which instituted the Special Agricultural Worker program and two guest worker programs (H-2A and Replenishment Agricultural Worker). These were intended to provide a legal work force that could join unions and result with better border control in reducing illegal immigration and creating better working conditions for the legal agricultural labor force (Martin 2002). These objectives have not been realized given that in the first part of the decade: an estimated 50% of all hired workers in crops and livestock farming, 25% in meat processing and 17% in food services are undocumented or unauthorized workers (Wells and Villarejo, 2004; Passel, 2005; Simonetta, 2006). These changes have also been happening in the context of the influence on international migration of the North American Free Trade Agreement (NAFTA), which came into force in 1994, although it did not formally include labor mobility as part of the framework agreement. The economic changes wrought by NAFTA have shifted relative economic power between the signatories to the agreement with differential effects on migration and on relative wage levels occurring among Mexico, USA and Canada (Canales, 2000; Aydemir and Borjas, 2007).

2.1.2 Changes in European farming and rural populations

Europe emerged from the 1940s with the sector predominantly consisting of small ‘mixed’ farms. As technology advanced during the following 50 years the number of farms and the number of farmers and farm workers has declined dramatically. In West Germany, for example, large farms (i.e. those over 2 ha) have declined from over 1,000,000 to less than 400,000, while the number of ‘small farms’, mainly run by part-time farmers has declined even more dramatically. At the same time the area of farmed land has only declined from 12.8 million ha in 1949 to 11.4 million ha in 2001 (Gov. Germany, 2006), indicating that there has been a dramatic increase in average farm sizes (Figure 2-6). In France the agricultural workforce declined from 8% to about 4% of the total working population in between 1977 to 1997. However, since the reform to the Common Agricultural Policy (CAP) in 1992 this decline in Europe, both in agricultural employment and the number of farms, has slowed down as can be seen in the annual percentage changes in labor force. Different countries and different areas in those countries have followed this pattern since 1990 to varying extents.

Insert Figure 2-6. Changes in the number of farms in West Germany 1949-2001

The changes in the agricultural labor force differed greatly throughout Europe with a noticeable North-South divide. Southern European countries such as Spain and Portugal lost more than a third of their labor force between 1987 to 1997 while the average for the European Community for was a 25% reduction. This more dramatic decline reflects the fact that these southern Member States traditionally have a more labor-intensive Mediterranean style of agricultural production; approximately 9% of jobs in countries with Mediterranean production systems were associated with farming (Eurostat, 1997). Greece has a particularly high rate agricultural employment (about 20%). Northern European countries such as Denmark and the UK showed average agricultural employment figures closer to 3% for 1997.

In western Europe, individual national migration policy has been gradually subsumed under general EU agreements, although as exemplified by the expansion of the Union to 27 members, full legal labor mobility for citizens of EU states may be delayed and circumscribed by a number of local national regulations. The UK, for example, has developed regulations (e.g. the Seasonal Agricultural Workers Scheme: SAWS) that respond to the need to attract farm workers for seasonal and temporary employment, building on a long history of dependence on migrant workers both from within and outside the UK (e.g. Collins, 1976). This demand has continued and a preference for migrant workers in agriculture remains strong (Dench et al., 2006).

The structure of demand for migrant workers in UK agriculture has been described as dependent on the relationship between growers and retailers; recent changes in favor of retailers has meant a decline in margins for growers. Worsening terms of trade for the growers has been reflected in changing demands made of the workforce, which include more demanding working practices and lower wage rates. The characteristics of the workforce desired by the growers changed accordingly with greater premium put on reliability and the capacity and willingness to accept hard work and lower wages. Growers report that foreign nationals have provided these characteristics more readily, possibly due to their relative lack of security and greater vulnerability and the attraction of high earnings relative to home-country wages and immigration/work permit status (Rogaly, 2006; Frances et al., 2005).

The accession of CEE countries from 2004 to 2007 has changed the supply and character of migrant labor to western European agriculture and to southern EU states such as Greece (Kasimis and Papadopoulos, 2005). Progressive opening of labor markets in western Europe for workers from the new EU states has offered migrants a greater range of work and increasing confidence in asserting employment rights and some evidence has been forthcoming of possible shortages in the supply of seasonal agricultural workers from these sources (e.g., Topping, 2007). These changes have their own cascading effects illustrated by the re-focusing of the SAWS scheme in the UK to relate primarily to workers from Romania and Bulgaria who can only obtain work permits in the UK for agricultural labor. These two countries are the latest to join the EU; most western EU members states (including the UK) have imposed transitional restrictions on the movement of workers to their economies. In turn, there is some evidence that improvement in the economies of new EU member states, in addition to the movement of workers from those states to more developed EU states, has created opportunities for migrants from Russia, Ukraine and Moldova and other former USSR states, some of whom are available for work in the agricultural sector (Patzwaldt, 2004).

The changes in CEE are more complex as collectivization greatly reduced the number of farming units in some countries (e.g. E. Germany and Czechoslovakia) but not others (e.g. Poland). Following the demise of collectivization, there has been a variable re-allocation of land to former owners resulting in fragmentation of the farming units, which has been followed by a re-amalgamation of the small units to create more financially viable enterprises (Bouma et al., 1998). An underlying factor in most transitions was the situation of the land and credit sectors, which together determined the ability - and sometimes the identity - of new landowners and farm-workers during the processes of land restitution and business privatization. In some countries, such as the Czech Republic, Slovenia and much of Poland, viable private farming businesses emerged quickly in the hands of families or companies. In Russia, Belarus and the Ukraine, with their much longer period under communist leadership and only partial acceptance of market-oriented systems, structural transformation in the countryside was slow and patchy, despite harsher economic conditions.

Despite the general trend observed across Europe for a decline in farm numbers, increase in farm size and laying-off of farm workers, some countries have seen a recent change in emphasis towards developing new on-farm enterprises, expansion into higher value-added crops and engagement in environmental schemes. These activities have actually resulted in an increase in agricultural labor in countries such as Denmark and Greece. Similarly, the recent rise in consumer demand for organic produce has seen an increase in labor in this part of the farming sector to meet needs of labor intensive operations and provide the necessary technical support. For example, data for Denmark has shown that conversion to organic farming has lead to a 38% increase in labor costs. A small increase in job creation in the agricultural sector is also resulting from the increase in agrienvironment schemes such as those being implemented in the UK.

The contribution of women to the agricultural workforce largely reflects the overall declining trend in farm employment in the European region. Overall, women make up more than one in three of the European agricultural workforce. However, women make a greater contribution to the agricultural labor force in Southern European countries than Northern, with the exception of Finland. In France, fewer farmers' wives now work on the farm, approximately half in 1997, as opposed to three-quarters in 1979. Part-time work is also less widespread in Northern European countries compared with southern Europe. This high level of part-time employment in southern Europe is associated with the greater number of seasonal activities in this region and is reflected in the employment of both men and women, but is generally more common among women.

Across the EU, women have lower overall labor force participation rates compared to men, higher levels of participation in part-time work, higher rates of unemployment and lower wages (nearly 25% below those of men) (Daly, 1991). Part-time work is by and large a female phenomenon; 85% of the part-time workforce in the EU is female. Non-standard employment (zero hour contracts, casual and seasonal work, temporary work, home working and unpaid family work) account for a disproportionately high share of women's employment. In a majority of EU member countries, at least 10% of the female labor force is in temporary employment with the highest rates in the Iberian countries and Greece. Outwork and homework are almost exclusively performed by women. In the more marginalized areas of the EU, two different developments are affecting farm women. On the one hand there is noticeable out migration, especially of young women, particularly in areas where a strong patriarchal culture coexists with difficult working and living conditions, e.g., Spain and Italy; on the other hand, there is also an increase in the number of female-headed farms (Spain, Portugal and Italy) (Fonte et al., 1994). Women provide safety nets where male outmigration has become a dominant feature. In these areas, women adjust farming to reflect the reduced availability of labor (e.g. smaller areas farmed, conversions to extensive farming, greater emphasis on subsistence, cooperatives, and agrotourism) and receive remittances from their spouses.

In CEE countries women are mainly employed as low-skilled workers. As in North America, farm household income in Europe is increasingly from off-farm salaries. The reduction in agricultural employment has, therefore, had a generally greater negative effect on female employment.

Rural women and poverty in the EU. Since a key trend in Europe is concentration (regional, sectoral and among firms), the division between the richer and poorer countries and the more and less prosperous regions is expected to deepen, as are the divisions between women. Within the EU, large regional imbalances occur. Portugal had the highest incidence of poverty followed by Spain, Ireland, Greece and the United Kingdom (Table 2-3). In four out of the six countries where poverty rates are reported by economic activity of the household head, they are higher for farmers than for any other group (Denmark, Germany, the Netherlands and Portugal).

With the exception of the Netherlands, female-headed households have higher poverty rates than male-headed households, with the highest incidences of poverty among female-headed households occurring in the UK, Ireland, France and Spain (Table 2-3). Several countries also have an unequal ratio of poor men to poor women. For example, in Germany and the UK there are 120 to 130 poor women per 100 poor men. In Italy and the Netherlands the ratios are nearly equal, while in Sweden the ratio is reversed, with fewer poor women (90-93 women per 100 men). The existence of strong family ties (Italy), high rates of female employment (Sweden) and a strong system of social assistance (the Netherlands) appear to influence these ratios positively (UN, 1995). In general, rural women constitute one of the major groups most vulnerable to poverty in the Western European population – as members of poor farm families, as female heads of household and as off-farm workers (Borjas and de Rooij, 1998).

Table 2-3. Poverty rates per household group as a percentage of national poverty rates

2.2 Farm Policies and the Development of NAE Agriculture

Farm policies have played a major role in the transformation of the agricultural sectors in Western countries during the last six decades and clearly contributed to the rapid adoption of new technologies and to dramatic increases in output and productivity. The agricultural legislation and policies of most Western countries during the past fifty years have had two underlying themes. One is to provide farm families with incomes equivalent to those in other segments of society; the second is to ensure an adequate and safe food supply for all the people in the country. To these ends a complex combination of measures has been produced, which at one end of the spectrum has attempted to keep small-scale farmers on the land and at the other has encouraged the consolidation of holdings into efficient mechanized units. Quotas and tariffs barriers have been used to protect local production from foreign competition. Price supports, production subsidies and supply controls have all been used to raise minimum family incomes while meeting some government budget constraints (Stanton, XXXX).

2.2.1 US farm policy: A legacy of the Great Depression

The US farm policies implemented after WWII were designed and tried during the Great Depression. As part of the Great Depression, falling prices of agricultural products gripped all the rural areas, prompting the federal government to intervene into agricultural markets to support farmers' incomes, stabilize prices and guarantee cheap food to low income populations (Dmitri et al., 2005). The most important instruments were production controls and government loans.

Beginning with Franklin Roosevelt's New Deal in 1933, the solution to rapidly falling farm incomes was primarily price supports, achieved through dramatic reductions in supply. Supply controls for staple commodities included payments for reduced planting and government storage of market-depressing surpluses when prices fell below a predetermined level. For perishable commodities, supply control worked through a system of marketing orders that provided negative incentives for producing beyond specified levels. In these farm programs were the seeds of later food programs, including food stamps, commodity foods and school lunch programs. The combination of price supports and supply management functioned as the general outline of Federal farm policy from 1933 until the present and continues to figure in current debates, although the mechanisms and relative weights of the policies' components were modified by successive farm legislation. In some years, notably during World War II and postwar reconstruction and again during the early 1970's and mid-1990's, global supplies tightened sharply, sending demand and prices soaring above farm price supports and rendering acreage reduction programs unnecessary. But for most of the period, repeated cycles of above-average production and/or reduced global demand put downward pressure on prices keeping the programs popular and well funded. Continued public support for direct intervention after World War II arose for different reasons. The low prices and consequent low farm incomes of the 1920s and early 1930s resulted from surpluses created by sharply reduced global and domestic demand, beginning with Europe's return to normal production after World War I and followed by the international economic depression of the 1930's. In contrast, surpluses following World War II resulted from rapidly increasing productivity, exacerbated by continuing high price supports that kept production above demand.

The apparent success of production controls and price supports in raising and maintaining farm incomes by the mid-1930's, made a continuation of these policies publicly acceptable. Nonetheless, intense debate between proponents of high price supports and those who believed farm prices should be allowed to fluctuate according to market demand continued from the mid-1950s to the mid-1960s. The debate was set in the context of large surpluses, low prices and efforts led by the Eisenhower administration to return the US economy and government bureaucracy to pre-New Deal, pre-World War II structures. Out of the debate—between advocates of very high price supports and mandatory production controls and those who wished to end direct government market intervention—came a compromise for farm policy. The Food and Agriculture Act of 1965 made most production controls voluntary and set price supports in relation to world market prices, abandoning the "parity" levels intended to support farm income at levels comparable to the high levels achieved during the 1910's. A system of direct income support ("deficiency") payments compensated farmers for lower support prices. Some exports programs aimed at concessional prices and food aid programs (PL 480) were implemented during the 1950's and 1960's in addition to programs already in place to promote exportations in order to deal with a part of excess output.

The debate over price supports and supply control recurred with enough intensity to divert the direction of policy in the mid- 1980s. The new setting was the farm financial crisis and its aftermath, along with efforts by the Reagan presidency to place the American farm economy on a free-market footing. This time, with steadily increasing government stocks of program commodities and Federal budget deficits at record levels, the argument against continuing expensive government support of the farm economy gained support. At the same time, the farm crisis began to undermine some of the farm sector's confidence that domestic price supports and production controls were a very effective way to secure US farm income in a global economy. Supported US prices reduced international marketing opportunities and increasing global supplies undercut domestic production control efforts. Farm legislation passed in 1985 and 1990 maintained the traditional combination of price supports, supply controls and income support payments, but introduced changes that moved farmers toward greater market orientation i.e. lower price supports, greater planting flexibility and more attention to developing export opportunities for farm products. Also was introduced in the 1985 Farm Bill environmental cross compliance measures in order to address specifically issues of soil erosion and conservation of humid areas. This Farm Bill also reintroduced direct subsidies to farm exports: Export Enhancement Program (EEP) and Targeted Export Assistance (TEA).

The stable economic development provided by farm programs in conjunction with rapid technological development resulted in rapid adoption of new and improved technologies on farms, relatively heavy investments in non-farm produced inputs, increased production efficiency and a rapid rate of growth in aggregate production capacity which exceeded aggregate demand (Cochrane, 1987).

There are several shortcomings of these farm programs. First is the failure to understand the structural excess capacity problem confronting commercial agriculture during the period between the end of the Korean War and the increase of the demand for agricultural exports at the beginning of the 1970s. This problem was largely understood as a temporal one. That led to various weaknesses in the farm programs: for instance, unwillingness to impose strict production controls and the tendency to impose production controls over only the commodity in most serious oversupply while permitting the released resources to shift into the production of other commodities. This last weakness was not seriously addressed until the 1980s. Another important shortcoming of the farm programs was the almost complete reliance on acreage controls as a means of controlling supply which induced the substitution of fertilizer, pesticides, machinery and power for land and labor, contributing to the land and water pollution of modern agriculture (Debailleul, 2000). In addition, while acreage diversion was also considered as a means to reduce the soil erosion, farmers tended to divert the less productive parts of their land and to intensify the agricultural practices on the most fertile part of their land, often the most vulnerable to the erosion. The farm policy was supposed to protect farmers against sharp declines in agricultural prices and in the same time to contribute to provide consumers with declining prices for food, what was possible due to the improvement in farm productivity. But experience shows that in periods of rapidly increasing farm prices like during the period 1972-1975, consumers were not protected against the rise of food prices.

2.2.2 Canada: A bipolar farm policy

In the five decades following WWII, a highly complex set of programs and institutions were implemented as Canadian farm policy. This uncommon situation was due to two reasons. First, the federal government as well as provincial governments both have the jurisdiction to intervene in the agricultural field, so some provinces, like Quebec, have adopted a set of farm programs in the last few decades. The second major reason was the bipolar structure of Canadian agriculture: an export-oriented western agriculture devoted to grain and oil-seed crops and a domestic-market oriented agriculture in Ontario and Quebec specialized in dairy, poultry and egg production. In these latter systems, supply management and border protection have been implemented as instruments to adjust the supply to the domestic demand. Beginning in the 1930s, marketing boards were implemented in the western provinces; their monopoly on marketing grain outside of the country was considered the best way to assure good prices for farmers. However, during the 1950s and 1970s some other programs were implemented, including a program to subsidize the transportation of grain from Prairies to the central and eastern provinces and the implementation of minimum prices for several crops.

During the 1990s, the federal government undertook a drastic reform of its farm programs. Because of budgetary deficits, combined with trade liberalization and free-trade agreements, the legitimacy of such programs was questioned. Due to budgetary constraints, some programs were phased out and the direct support of farm price programs was abandoned in favor of programs which supported the net average farm income, thereby decoupling farm payments. The supply management programs have been maintained but the future for these programs is still uncertain.

2.2.3 Common Agricultural Policy and the building of a single market

As with North American agriculture, European agriculture was greatly affected by the economic crisis of the 1930s. After WWII, most Western European countries pursued protectionist policies in order to increase self-sufficiency and reduce their agricultural trade deficits. As a consequence, food prices were maintained at a high level. Production responses to high food prices differed from country to country. In several countries, the agricultural sector began to modernize and become more competitive, while in other countries, agricultural structures were still inefficient, leading to greatly different agricultural systems among those countries working to form the European Community.

The implementation of Common Agricultural Policy (CAP) was supposed to be divided in two periods; the period from 1958 to 1970, the "transitional period" was supposed to experiment with new instruments and the "permanent period" beginning in 1970 was devoted to the achievement of a single agricultural market. Actually, the transition to the permanent phase was completed in 1968.

The CAP was designed with several different objectives, including increasing agricultural production through the development of technological progress as well the efficient use of factors of production, in particular labor; ensuring equitable standards in living for farm people particularly through an increase of personal income; stabilizing markets; securing the food supply and ensuring reasonable prices for consumers. This domestically oriented farm policy was based on three major principles;

- A unified market in which there is a free flow of agricultural commodities within the EEC;
- Product preference in the internal market over foreign imports through common customs tariffs; and
- Financial solidarity through common financing of agricultural programs.

Thus, individual nations were supposed to gradually leave their decision-making power in agricultural matters both at the domestic and international levels in the hands of the Community. Decisions made in Brussels were to be applicable equally to all member states. Today the CAP's main instruments include agricultural price supports, direct payments to farmers, supply controls and border measures. Major reform packages have significantly modified the CAP over the last decade. The first reform, adopted in 1992, began the process of shifting farm support from prices to direct payments. The 1992 reforms reduced support prices and created direct payments based on historical yields and introduced new supply control measures. These reforms affected the grain, oilseed, protein crop (field peas and beans), tobacco, beef and sheep meat markets. The second reform, "Agenda 2000" began in 2000 in preparation for EU enlargement. Similar to the first CAP reform, Agenda 2000 used direct payments to compensate farmers for half of the loss from new support price cuts. Agenda 2000 reforms focused on the grain, oilseed, dairy and beef markets.

The most recent reforms (begun in 2003 and 2004) represent a degree of re-nationalization of farm policy, as each member state will have discretion over the timing and method of implementation. The 2003 reforms allow for decoupled payments—payments that do not affect production decisions—that vary by commodity. Called single farm payments (SFP), these decoupled payments will be based on 2000-02 historical payments and replace the compensation payments begun by the 1992 reform.

When member states implement the reforms, compliance with EU regulations regarding environment, animal welfare and food quality and safety will be required to receive SFPs. Moreover, land not farmed must be maintained in good agricultural condition. Coupled payments, which can differ by commodity and require planting of a crop, are allowed to continue to reinforce environmental and economic goals in marginal areas. The CAP budget ceiling has been fixed from 2006-13; if market support plus direct payments fall within 300 million euros of the budget ceiling SFPs will be reduced to stay within budget limits.

Domestic price support

Prices for major commodities such as grains, oilseeds, dairy products, beef, veal and sugar depend on the EU price support system, although price support has become less important for maintaining grain and beef farmers' incomes under the CAP reforms. The major method of maintaining domestic agricultural prices is through price intervention and high external tariffs. Farmers are guaranteed intervention prices for unlimited quantities of eligible agricultural products. This means that EU authorities will purchase at the intervention price unlimited excess products meeting minimum quality requirements that cannot be sold on the market, which are then stored or sold for export with subsidies.

Other mechanisms, such as subsidies to assist with surplus storage and consumer subsidies paid to encourage domestic consumption of products like butter and skimmed milk powder, also support domestic prices. The 2003 reforms, however, cut storage subsidies by 50%. Some fruits and vegetables are withdrawn from the market in limited quantities by authorized producer organizations when market prices fall to specified levels. Reforms have lowered the cost of the CAP to consumers as intervention prices have been reduced. However, taxpayers now bear a larger share of the cost because more support is provided through direct payments.

Direct payments

While price supports remain a principal means of maintaining farm income, payments made directly to producers provide substantial income support. Compensation payments for price cuts generated by the 1992 reform began in 1994 and were increased for the Agenda 2000 reform. These compensation payments were established on a historical-yield basis for arable crops by farm and required planting to receive a payment. Production requirements have been eliminated in the 2003 reform for both crops and livestock, with payments made to farmers based on the average level of payments received during 2000-02. Direct payments currently account for about 35% of EU producer receipts and for an even higher percentage of net farmer income (once input costs are subtracted from receipts).

Supply control

The 1992 reforms instituted a system of supply control that has been maintained through subsequent reforms. To be eligible for direct payments, producers of grains, oilseeds, or protein crops must remove a specified percentage of their area from production. Small producers are exempt from the set-aside requirement. Supply-control quotas have been in effect for the dairy and sugar sectors for nearly two decades.

Border measures

The CAP maintains domestic agricultural prices above world prices for most commodities. In preferential trade agreements, such as those with former colonies and neighboring countries, the EU satisfies consumer demand while protecting high domestic prices through import quotas and minimum import price requirements. The CAP also applies tariffs at EU borders so that imports cannot be sold domestically below the internal market prices set by the CAP. Although the Uruguay Round of Agreement on Agriculture called for more access to the EU market, market access to the EU's agricultural sector remains highly restricted in practice. In addition, the EU subsidizes the agricultural exports to make domestic agricultural products competitive in world markets.

Additional aspects of 2003 reform

Important components of the 2003 reform reflect a philosophical change in the approach to EU agricultural policy. For the first time, much of the pressure to reform the CAP came from environmentalists and consumers. The requirement to comply with environmental and animal welfare standards to qualify for the SFP reflects these pressures. Moreover, farmers must meet food quality and food safety regulations for payments to continue. Another important feature of the 2003 reforms is the move from a price support policy to an income support policy through decoupled payments. EU farmers will have more choices in their planting decisions because of decoupled payments. Commodity support prices continue to exist but at lower levels, while direct payments to farmers without requirements to plant a crop are more widespread.

There is also a marked shift in the way rural development is treated. The 2003 CAP reforms established two pillars in the budget: Pillar I for market and price support policies and Pillar II for rural development policies. In the reforms, a ceiling was imposed on Pillar I spending, whereas Pillar II spending seems open-ended. The intended budget for rural development will more than double over the next 10 years, while the CAP budget for Pillar I may only increase by 1% per year in nominal terms from 2006-13. Moreover, in a concept called modulation, SFP payments greater than 5,000 Euros are reduced by 5%, while farmers whose SFP is less than that are not penalized. The budget funds saved through modulation are transferred to the Pillar II rural development fund. At least 80% of the funds from the penalties will remain in the country where the SFPs were reduced and are to be used for rural development purposes.

Policy and Productivity. The increase in agricultural productivity within the EC was very rapid. While increases in the rate of agricultural productivity in the United States appeared in the 1930s, this trend didn't began until the 1950s in the EC and continued in the subsequent decades primarily due to the implementation of CAP. While protectionist policies were employed by EC member countries before the CAP was established in 1962, it has played a fundamental role in increasing the size of supply and the agricultural productivity

Benefits and shortcomings of farm policies

Consumer benefits from price stabilization are lower probabilities of shortages and extremely high prices. A large part of gains in agricultural productivity have also been transmitted to the consumer through a long-term tendency of declining real farm prices. Food processing firms benefited from more stable supplies and prices that resulted in more efficient use of processing facilities and improved management decisions. The agricultural supply industry also benefited as farm programs constituted great incentive for investment and adoption of new technologies. For the same reasons, livestock producers also gain from grain price stabilization and government storage policies.

Despite the underlying theme of support for the family farm in both NA and the EU policies, long run effects promoted larger farms. For instance, higher price supports, benefits, deficiency payments, disaster payments and directs aids are generally proportional to output or to acreages. Between 20% and 30% of the farmers are able to capture between 60% and 80% of government payments in either the US or the EU. For instance, 70% of the direct payments of CAP during the financial year 2000 went to 16% of EU eligible farmers.

The results of US and European attempts to dispose of surplus commodities have been particularly damaging to the agricultural sectors of the developing countries. The availability of cheap surplus food from Europe and the US has made it possible for some nations to maintain urban food prices at relatively low levels. This discouraged production by their own farmers and encouraged rural people to migrate to the cities. In addition it made poor nations dependent upon American and European willingness to continue to overproduce agricultural commodities (Bonnano et al., 1991). Moreover, the modernization and intensification of agriculture that have been promoted by these policies has had damaging environmental and social consequences that have not been entirely addressed by reforms.

2.2.4 Agricultural policies in CEE countries

Three broad stages can be identified in agricultural price policy reforms in CEE countries. These began in the early 1990s with the dismantling of administered pricing, production targets and the state monopoly on trade as well as the adoption of price and trade liberalization and limited intervention in agricultural markets. This was followed by an *ad hoc* reapplication of controls on price and market support and on trade restrictions. By the late 1990s and continuing up to EU accession by many countries in 2004, agricultural policy was dominated by the alignment of their agricultural sectors with that of the European Union, particularly to the CAP and to food hygiene and welfare standards (OECD, 2001). Structural reform was directed to improve overall performance of the agrofood sector such as investment to improve market infrastructure, to modernize plants and equipment and eliminate management inertia, as well as consolidation of holdings to ensure viable farming units which depend on a functioning land and land lease market (Cochrane, 2002)

EU support was provided to certain CEE countries for pre-accession restructuring through various programs, with the Special Accession Programme for Agriculture and Rural Development (SAPARD) being important in agriculture. SAPARD is a 7 year program which started in 2000 and allocated two-thirds of its funding program to Poland, Romania and Bulgaria.

In Russia and the NIS, reforms were required in farm-level organization and management and in the development of the physical and institutional infrastructure. Private farming had not developed during the 1990s to any substantial degree and land and rural credit markets remained ineffective as a credible commercial legal system to protect property and enforce contracts remained undeveloped (Virolainen, 2006). However in Russia, there were signs by the 21st century that vertically integrated forms of organizations were emerging. It has been suggested that any productivity gains in Russia in the short to medium term might come more from strengthening vertical ties for production and distribution rather than from real technological or systemic change because of the increasing attractiveness for investment that would result (Liefert et al., 2002).

In Russia in particular there has been ‘a rapid, quite fundamental change in the principles for developing agricultural production’ (Virolainen, 2006). The emphasis has shifted from the family farm to supporting large, commercial farm enterprises. These enterprises form so-called agroholding companies, consisting of either a single farm enterprise or a collection of individuals. These agroholdings may also be part of a larger industrial-economic grouping, such as the Alfa group, Interros, Lukoil, Metalinvest or Rusagro. These enterprises perform as vertically integrated enterprises ensuring raw material supply to group member companies and may be used to ensure the supply of foodstuffs for the core company’s employees.

The political reforms that began in 1989 shifted the emphasis in agricultural policy toward developing an efficient, productive, export oriented agriculture based on comparative advantage instead of a focus on responding to basic production targets formulated by national plans with their goal of achieving self sufficiency. At the same time the role of agriculture in the post communist era declined relative to other sectors that began to achieve a relatively faster rate of development (OECD, 2001).

The reforms led to a substantial decline in agricultural production in the Central and Eastern European countries (CEECs).[1] The gross agricultural output fell by between 15 and 30% for these countries between 1989 and 1992 although for both the Czech Republic and Slovenia that followed a brief initial increase of some 10 percent. The decline subsequently moderated for these countries during the remainder of the 1990s and even reversed for the Czech Republic, Poland and Hungary. For Albania, by 1998, output had even reached higher than the 1989 level by over 10% annually (Macours and Swinnen, 2000).

Political and economic reform in Russia, republics of the Soviet Union and the Newly Independent States (NIS) of the 1990s produced similar consequences for agricultural *productivity*. Estimates for Russian crop production indicate a drop of 8per cent in productivity overall between 1993 and 1998, while overall agricultural productivity rose in Russia and the Ukraine between 1992 and 1997 but only by 7% and 2% respectively (Liefert et al., 2002). The major changes in Russian agricultural production and trade following transition included a halving of the livestock inventory resulting from a reduction in imports of animal feed. Fertilizer, machinery and fuel use also fell substantially, resulting in cuts in domestic grain yields and harvest levels. The same applied to the Ukraine as fertilizer output was switched to export supply (Liefert et al., 2002).

2.3 Changes in Market Structure

Specialization in agricultural production has been accompanied by significant changes in market structure for both agricultural inputs and outputs. Economic power in food and agriculture and thus the power to make decisions about what to produce and where to produce it, has moved toward fewer and fewer transnational firms which are embedded in a web of relationships in food production, from genetics to food retailing (Yoon, 2006). Some view these changes positively as a

[1] The countries that are included under the rubric of the CEECs differ. Some authors restrict the definition to the ten countries that underwent accession to the EU between 2004 and 2007 namely Estonia, Latvia, Lithuania, Poland, Romania, Slovakia, Czech Republic, Hungary, Bulgaria and Slovenia. Others include Albania and the remaining Balkan states, but these are also referred to as the South East European Countries (SEEC). Most of the material here regards the CEECs as to the ten accession countries, unless other countries are referred to specifically.

way to increase efficiency in the food system (Barkema et al., 2001) while others point toward increased marginalization of farmer and rural livelihoods and negative impacts on communities (Goldschmidt, 1978; Lobao, 2000; Stofferhan, 2006)

In Europe, concentration in the food system started at the retail stage, becoming most obvious during the 1980s and 1990s (Vorley, 2003). In the US, concentration of ownership and control became most visible in the production and processing stages, especially in the poultry sector in the mid-twentieth century. Contrary to European trends, in the US and Canada increased market share by fewer firms occurred in the agricultural input sectors and the food processing stage much earlier than in the food retailing sector.

Horizontal integration is occurring at all stages of the food system from the genetics to raw agricultural commodities to food retailing. The concentration ratio (CR4), which is a measure of the market share of the top four firms in a particular commodity, has continued to increase during the past decade in the US The largest four processors for all the major commodities now have from 50 to 80% of the market share (Table 2-4 and Figure 2-7) which can indicate decreased competition in the marketplace forcing farmers into a relatively powerless position vis-à-vis suppliers or buyers. Others argue that competition is sufficient for farmers to obtain a fair price (Tweeten, 1992; McDonald et al., 2000). Nevertheless, farmers across the NAE faced with decreasing choices buying agricultural inputs and selling outputs can face a cost-price squeeze that affects their ability to earn a livelihood from agriculture.

Insert Table 2-4.Concentration in the US and Canadian food industry
Insert Figure 2-7. Trends in consolidation in the US food industry from 1990 to 2007

The structure of market in agricultural inputs has changed markedly in the last 50 years. For instance, two firms provide most of the fertilizer used today in North America while one firm has a 25% market share for fertilizers in Europe. The seed industry is even more instructive for other inputs. Globally, the seed industry is increasingly driven by NAE based transnational agrifood businesses (UNCTAD, 2006). Four NAE-based transnational companies provide almost 30% of the world’s commercially available seeds while NAE accounts for 43% of the commercial seed market globally (Table 2-5).

Insert Table 2-5. Global seed sales by NAE based companies

Many of the changes in NAE were anticipated by the changing nature of the US seed industry, the most heavily commercialized in the world. In the 1930s, over 150 companies formed to sell hybrid maize, but by the mid-1960s, American farmers had essentially abandoned open-pollinated maize varieties with nearly all maize acreage planted to hybrid maize (Fernandez-Cornejo, 2004). Maize provided the kernel of transformation for the seed industry in general. Between 1970 and 2000, small private seed firms essentially vanished, with more than 50 acquisitions of seed firms by pharmaceutical and chemical firms (Fernandez-Cornejo, 2004). By the 1980s, the maize seed market was dominated by two firms and by the late 1990s, over 90% of cotton seed, 69% of maize seed and nearly half of soybean seeds were sold by the four largest firms in each crop. The same privatization trends are seen in Europe and as a consequence, the private sector is becoming increasingly important.

One of the more striking features of industry changes in the last two decades has been the convergence of ownership between agrochemical and seed/genomic firms. This strategy has worked well "to better control and market proprietary lines of chemicals, genetic technologies and seeds, often sold in a single-bundled package" (UNCTAD, 2006). These bundles can be attractive to farmers and farmer managers as a purchased management tool. However, such packaged bundles can reduce flexibility of on-farm management strategies for pests and weeds, as well as implementation of novel consumer-driven production systems and increase reliance on purchased inputs (c.f. Hendrickson and James, 2005).

When farmers sell their products, they also face highly concentrated markets. In the US less than 10 firms slaughter and process most of the broilers, turkeys, cattle (heifers and steers) and pork in the United States. Many of these are the same firms that operate in Canada. Moreover, the CR4 ratio has been increasing for all livestock processing – particularly steers and heifers and hogs – since 1980 in the US (USDA, 2000) Livestock production in Europe is less consolidated than in North America. For instance, the top 10 integrated broiler producers in Europe account for only 36% of production compared with 66% in the US.

The grain trading sector worldwide is dominated by three NAE based firms (reference). These three players are in the process of rationalizing crushing capacity, closing down some factories and increasing the utilization rate of others.

During the 1990s, intensive mergers among farmer dairy cooperatives left only two major US cooperatives, one of which currently produces 33% of the US milk supply. Two of the largest private companies merged to become the largest dairy processor, controlling 30% of the US milk supply (Hendrickson and Heffernan, 2005). Retail consolidation in dairy increased prices for consumers, yet decreased farm gate prices (Cotterill and Franklin, 2001). Across Europe, there has been a process of international consolidation in dairy processing, led by farmer-owned businesses in the race to remain competitive with multinational companies. Concentration in dairy is also a trend in Central and Eastern Europe (Csaki and Forgacs, 2004).

It is estimated that 60% of retail food purchases in the United States go to the ten largest global food corporations (Lyson and Raymer, 2000). The major food manufacturing countries in Western Europe are France, Germany the UK and Italy (Figure 2-8). Meat, beverages and dairy are the biggest sectors, comprising 20, 15 and 15% respectively of over EUR 600 billion production value in 2001 of (USDA-FAS, 2003). It is Europe's leading industrial sector and third-largest industrial employer and concentration in the sector is relatively low (Table 2-6).

Insert Figure 2-8. EU-25 Food and drink sector 2001, value of production (EUR billion) estimates

Insert Table 2-6. Top European food manufacturers, ranked by turnover in 2002

Another striking feature of the food system in NAE is that the same firms appear in different sectors of the food system, from genetics to processing because of vertical integration. While not a new term, or process, vertical integration has accelerated rapidly in NAE since 1945. Mostly, this process combines the management (but historically ownership) of a series of stages in the food system. Vertical integration leads to supply chain management, which when exercised in non-competitive markets resulting from horizontal integration, replaces the competitive market providing the coordinating function in a competitive system (Hildred and Pinto, 2002).

We can look to NAE, particularly the US, to see some early examples of vertical integration, e.g. poultry. The poultry industry has now become the prototypical model of industrialized agriculture and is often referred to as a model of the structure that may come to characterize much of US farming in the future (Perry et al., 1999; Hendrickson et al., 2001). Before the 1950s, chickens were raised on more farms in more regions of the US than any other farm animal. The chicken farmer was supported by thousands of local hatcheries, feed mills and processors where chicks, feed and other supplies could be purchased and the birds could be sold. Following the WWII, large feed companies recognized the broiler industry's potential for growth and moved quickly into the production of broilers (Heffernan, 1998; Martinez, 1999; Ollinger et al., 2000). These companies began buying up hatcheries and developing relationships with retailers. By 1960, 286 firms were selling broilers (Heffernan, 1972) and the top four firms controlled 12% of the market. By 1998, only 52 firms remained and in 2007 the top four firms accounted for over 58% of the market (Hendrickson and Heffernan, 2007). Today, a typical broiler complex includes breeder farms, hatcheries, feed mills, grow-out farms, processing plants and retail markets. Commercial feed firms became the major consolidators in the broiler industry traveling out 25 to 30 miles in a circle from the processing plant to the growers' buildings (Heffernan, 1984). The geographical layout is much the same today except the number of integrating firms and the number of processing facilities are greatly reduced. These firms have about 250 sets of processing facilities across the country producing broilers. Very few growers live in an area where two circles of competing integrating firms overlap. As a result, most growers live in places where they have access to only one integrating firm.

Vertical integration has been manifested through the development of food system clusters or integrated food supply chains; both terms connote a direct line of control for a firm from one stage of the food system to another (Barkema and Drabenstott, 1996; Drabenstott and Smith, 1996). In In 1999 three emerging food system clusters appeared to be dominant forces in the food system from genetic material to food manufacturing (Heffernan et al., 1999; Hendrickson and Heffernan 2002). These food chain clusters are still major entities in the agrifood system, but have significantly evolved, including mergers and divestments. Other strong firms remain that have likely formed, or will form, new clusters. It is important to note that much movement to reorganize supply chains in the early 21st century, particularly in the fruit and vegetable sector, has come from large, global retailers, all of whom are based in the NAE, especially in Europe.

One form of vertical integration is the agricultural contract, manifested either as a production or marketing contract. In the US, agricultural contracting covers nearly 40% of the value of agricultural production, up from 11% in 1969 (MacDonald and Korb, 2006). Production contracts exist when an integrating company retains ownership of the commodity as it moves through the chain, with growers receiving a fee for providing labor and/or capital (Sommer et al., 1998). In marketing contracts, farmers retain ownership and use the contract to specify price, quantity and quality of product to be delivered. About 10% of all US farms use a contract of some sort, with almost 50% of large commercial farms involved in contract production (MacDonald and Korb, 2006). Contract usage varies among commodities. In 2003, nearly 60% of hogs and almost 90% of poultry and eggs were sold through contract production, primarily production contracts. Crops like vegetables, fruit and rice tend to have higher rates of contracting than corn, soybeans, wheat and sugar beets. Marketing contracts are much more prevalent in crop production while production contracts predominate in livestock production. While contracting can provide risk management for producers, contract farming can also pose risks to social structure when it creates the structural equivalent of factory or piece-rate workers who lose control over decision-making or assets; and to family well-being given the contractor grower's asymmetrical bargaining power relationship with integrating firms (Hendrickson and James, 2005; Stofferahn, 2006; Hendrickson et al., 2008).

2.4 Changes in NAE Cropping Systems Since 1945

2.4.1 Changes in soil AKST and use since 1945

Soil is one of the basic natural resources and is vital for agricultural productivity across NAE, a region with extensive amounts of productive soils. Knowledge of soil is critical to agriculture, especially in low input agricultural systems, such as organic agriculture. Traditionally, knowledge of soil type on a particular farm passed from one generation of farmer to the next and traditional practices of manure application were followed to improved soil productivity. Since the end of the WWII, development and availability of soil analytical techniques has led to a more science-based approach for increasing and conserving soil productivity.

Soil testing facilities have been developed largely in response to issues related to agricultural productivity. Concerns such as nutrient depletion and acidification led to the establishment of soil testing programs at publicly-funded institutes in the late 1930's to the early 1950's. These provided services to help farmers make decisions about fertilizer and lime applications (e.g. Olsen et al., 1954; Mehlich, 1984). In recognition that saline and alkali soil conditions reduced the value and productivity of considerable areas of land in the US, the United States Salinity Laboratory was created in 1947 (Richards, 1954). During the 1970's soil testing expanded, providing additional tests and services in response to renewed emphasis on the efficient use of agricultural inputs such as fertilizers, largely due to the energy crisis and an increased public concern for the protection of water quality and prevention of pollution from chemical fertilizers. Similarly, increased ability to analyze trace elements allowed recommendations to be given to farmers concerning shortages, excesses or trace elements.

Until the 1980s, there was substantial investment by governments in soil science research, predominantly focused on soil productivity and aimed to increase agronomic yields. However, since the 1980s, this investment has decreased and the institutional knowledge about analytical methods for soils, water and plant material is lodged more and more in the US private sector. (Prunty, 2004). In contrast, following shrinkage in the 1980s, soil science is re-emerging as vital component of agricultural and environmental sciences in Europe, with a current EC strategy and publicly-funded research program to protect Europe's soils from erosion and degradation and ensure sustainable use (EC, 2006).

Extensive and detailed mapping of US and European soils was initiated following World War II and today has evolved into comprehensive, digital national maps of soils in many countries across NAE. This has resulted in more appropriate land use based on soil classification (e.g. rough pasture, arable land). Over the last three decades, there has been an evolution to, assemblage and development of long-term soil resource assessment technologies that are land or ecological. This is especially applicable to forestry management in both the US and Canada (Hills, 1952; Smalley, 1986; O'Neil et al., 2005). Since 1945, there has been development and refinement of soil and water conservation technologies (USDA-SCS, 1955; USDA, 1957; Troeh et al., 1980; USDA-NRCS, 1996; Tibke, 2002; Weeies et al., 2002).

There is greater appreciation of the value of manures and sludge for providing both nutrients and organic matter to soils used for crop production. Proper application rates have been increasingly understood to minimize movement of nutrients off site, which could cause adverse ecological effects e.g. eutrophication elsewhere. Organic systems are sometimes thought to lead to increased manure run off, due to their increased reliance on organic fertilizers (Stolze et al., 2000). However, studies from the UK at least (Shepherd et al., 2003) indicate that awareness of the problem has largely alleviated it. In addition, the reduced excess of nutrients on organic farms can have beneficial effects on water quality via reduced nutrient run off (Shepherd et al., 2003).

2.4.2 Changes in cropping systems in NAE

Increased productivity is the key change in NAE cropping systems. Arable crops, especially the major commodity small grain crops, such as wheat, barley and maize along with the oilseed crops (soybeans, oilseed rape, sunflower), the legumes (peas, beans) and root crops (sugar beet, potatoes) have formed the backbone of crop production in the NAE while fruits and vegetables, with their great range of crops, from lettuces to apple trees, make up the remaining production sector. Over the last 50 years there has been some change in the proportions of different crops grown, such as the increase in oilseed production, but the overall area of agricultural land has not increased during this period. In fact, data from FAOSTAT indicates an approximately 10% reduction in agricultural lands for the EU(15) and for the USA between 1961 and 2003, with a lesser decline in Canada. In the CEE, the amount of land in agricultural use initially remained constant after the end of the Socialist era, although today there seems to be increase in the amount of uncultivated land across the region, which by certain estimates amount up to 30% in some countries (OECD, 2001).

Insert Figure 2-9. Wheat yields in 10 NAE countries.

Despite stable or declining arable land, production of virtually all crops has increased significantly (Fig. 2-9), in some cases more than doubling, in NAE during this time. The increases in production, particularly in Western Europe and North America, have been stimulated by the increasing demands for food from the rising NAE population during the last 50 years. This was particularly important in the 1950s, as there were real food shortages in many countries in the years following World War II. Post-war agricultural conditions in the Soviet Union were dire, with famine conditions in 1946-47 (Medvedev, 1987) and per capita production of grain and meat below 1913 levels. These conditions were due to the direct destruction of farming and food distribution resources in CEE. In the western NAE, the continued momentum to increase production was encouraged by the politically driven agricultural financial support systems in Western Europe and USA (see 2.2), aimed at ensuring the continued viability of the rural economy. The Soviet Union turned to centralized planning, collectivization and ultimately the Virgin Land Program, when 36 million hectares in dry areas were ploughed and sowed in the late 1950s to increase grain production.

Although production lagged behind that in Western Europe and most of the world, CEE farms steadily increased arable production from 1945 to 1980 (Lerman et al., 2003). In the Soviet Union, by the mid-1950s cereal production exceeded the 1913 level and between 1950 and 1970 rose by more than 2.3 times to 186.8 million tonnes (Narodnoe khoziaistvo, 1971). After the breakdown of the collective farm system, there was a rapid decline in productivity starting in 1991, with large areas of arable land essentially left unfarmed. For instance, up to 40% of arable land in the Baltic States was abandoned in the 1990s, with a similar decrease in agricultural output (Lerman et al., 2003). This in turn led to a 38% decrease in per capita income in rural areas. Far less land was abandoned in Hungary and Poland where markets were more robust. There has been a recovery in production in most CEE countries, but production levels in the smaller countries are still only at 1960s levels (Lerman et al., 2003). Farmland in the larger countries, especially in eastern Germany, Hungary and Poland, was seen by investors from Western Europe as having good potential for further increases in production by applying modern technology and having relatively low labor costs. Some areas of arable farmland in these countries are increasingly owned by Western consortia. Most CEE countries are now members of EU-27 and EU management of CEE grain production is expected to increase it by around 25%, an increase of some 50 million tonnes. This increase has already become apparent in places like eastern Germany where yields of all grains now equal or exceed those in Western Germany.

Another factor in increased crop production in NAE has been the increasing demand for meat, (see discussion in 2.5) coupled with the increasing intensification of meat production often resulting in intensive housed systems, requiring large quantities of grain, protein and oilseeds. Increased crop production was facilitated by and to some extent stimulated by, the development of new cultivars and technologies aimed at increasing yields and decreasing yield threats from biotic and abiotic factors (e.g. pest and disease attack, weather impacts on crop growth and harvesting). Research on crop production inputs and the dissemination of the information to farmers has played a key role in providing tools for farmers to increase their production. The major contributors to these yield increases are:

1. breeding of higher yielding cultivars and the adoption of high-yielding hybrid seeds for planting;
2. increased availability of fertilizers and increased knowledge of how to use them;
3. development of new pesticides to control weeds, pests and diseases;
4. better understanding of the biotic and abiotic factors constraining yields, leading to optimizing agronomic practices (e.g. sowing dates, plant densities, fertilizer timing);
5. improvement in machinery design and range to assist optimization of crop production
6. increased use of irrigation;
7. enhanced mechanisms for technology transfer, such as development of national agricultural advisory systems; and
8. the delivery of information by the private sector, e.g. on the use of their products, it is as an important a source of information to farmers as is the public sector extension services and related public sector support.

These advances are summarized in data from the long-term Rothamsted wheat experiment (Figure 2-10), which clearly shows the role played by a number of different inputs in delivering higher yields.

Insert Figure 2-10. Yield responses on the Broadbalk winter wheat experiment at Rothamsted Research Station, UK since 1843 in relation to the introduction of novel agronomic practices.

While increasing productivity has been the main goal of the last 60 years, there is evidence of little increase in yields since 2000, suggesting that farmers may have reached economically optimal yield achievable with the cultivars available at the present time and in the current economic and policy atmosphere. Similar responses can be identified for other major arable crops.

As well as the direct contribution of science and technology to increases in yields, the establishment of effective technology transfer systems to ensure that the ‘new’ advice was conveyed to the farmer users was also of great importance. Such advisory systems have sometimes involved the public sector (government sponsored advice) and sometimes the private sector. In the US, development of an extensive public knowledge transfer system through the cooperative extension service of land-grant universities contributed greatly to agricultural productivity (Hildreth and Armbruster, 1981). However, today there is a transition from publicly supported technology transfer systems to private technology transfer systems (see Chapter 4). The former tended to be more holistic in approach while the latter has primarily been associated with commercially viable products, whether new agrochemicals or new cultivars (c.f. Fuglie et al., 1996).

2.4.3 Increasing cropping systems productivity through inputs

As noted above, changes in outputs of cropping systems across the NAE reflect changes in production and management systems that utilize inputs such as mechanization, labor, seeds, genetics, nutrients and irrigation, in new and different ways.

2.4.3.1 Mechanization

The last half of the 20th century saw dramatic changes in farming operations because of increased mechanization. The introduction of the diesel engine, compact combine harvesters and sophisticated hydraulic and transmission equipment has reduced labor requirements in weeding, harvesting and threshing (Park et al., 2005).

Improved efficiency and increase in machine scale may explain some of the decline in the number of harvesters and threshers observed in the USA in the 1960s, which has maintained a plateau since the mid-1970s. In contrast data for Europe showed a large increase in uptake during the 1960s and 1970s showing a continued investment in this machinery and reaching a peak in the number of machines during the mid-1980s.

New developments in mechanization also relate to precision agriculture, which seeks to improve performance by mapping the specific nutrient needs or levels of pest damage to growing crops in such a way that differing treatments may be provided within the same field (e.g. McBratney et al., 2005). By providing precise information about variable field conditions, precision agriculture can substitute knowledge for chemical inputs such as fertilizer and pesticides (Bongiovanni and Lowenberg-DeBoer, 2005), while improving management techniques for environmental and economic goals. It is often – but not necessarily, associated with the incorporation of new technologies (e.g. global positioning service or electronic sensors) into varying agricultural machinery (McBratney, 2005). Precision agriculture can benefit the environment by reducing excess applications of inputs and reducing losses due to nutrient imbalances or pest damage, but the necessary technology is at present best suited to relatively large farms so that the capital cost of investment can be spread over a large output, primarily in places like the United States and Canada (Natural Resources Canada, 2006).

In some CEE countries, the collectivization of agriculture tried to exploit economies of scale, particularly in the fields of mechanization and in the use of agrichemicals. In the Soviet Union, productivity advances were largely achieved by government-mandated and government-sponsored industrialization of agriculture. Thus, between 1950 and 1974 the production of plough-tractors increased by 79% to 218,000 units per year and the production of cereal harvesters increased by 91% to 88,400 units per year. However, investment in machinery was limited by lack of state resources for collectivized farms and lack of access to credit for private landowners (Kovach, 1999).

Another agricultural sector that has seen significant mechanization advances is glasshouse production, which is used for high value crops such as tomatoes and ornamentals. The use of glasshouses and other structures enable horticultural crops to be protected from frost, irrigated as required, protected from pests and disease and brought to market out of normal season in first class conditions. Since 1950 growing sophistication resulting from the use of automatic temperature, humidity and ventilation controls has improved performance and reduced the labor requirement. However, as transport becomes cheaper protected crops face growing competition from imports grown in climates that are more favorable. One response to this has been to devise cheaper ways of protecting crops, notably the use of plastic and polytunnels.

Mechanization of agriculture allows more timely completion of tasks and reduces labor requirements, thereby increasing productivity, avoiding labor shortages and eliminating unpleasant jobs. It also allows cropping of lands previously too difficult to cultivate. But mechanization also has disadvantages; including loss of jobs, costs of maintenance and fuel as well as elimination of hedges and expanded field size to accommodate larger equipment (Wilson and King, 2003).

The main drivers of mechanization have been the desire for greater productivity in the 1950-60s (European Environment Agency, 2003), the reduction of the labor leading to an increased quality of life and increased economic needs. Moreover, AKST has provided mechanisms for the achievement of engineering improvements for agricultural and forestry equipment and more sophisticated handling of milking, as well as allowing for the development of computer management in animal feeding. Thus, mechanization is correlated with field size across NAE, changed management systems and increased flexibility of land use and management. All of these changes have had very important economic, environmental and social implications.

2.4.3.2 Plant breeding, seeds and genetics

A key contributor to productivity increases in crops has been the major advances in crop breeding since the late 1930s, including the development of hybrid crops, cell fusion, embryo rescue and genetic engineering. Many of these new techniques derived from new discoveries in biological sciences and major advances in the fields of genetics (e.g. the discovery of the structure of DNA and the understanding, at the molecular level, of genes as physical entities that could give rise to Mendelian-style inheritance). Post WWII, the study of genetics led to the development of new techniques to introduce inheritable traits into organisms, a subset of the broad set of methods known as biotechnologies designed to adapt living things for the production of useful products. These new techniques include genetic engineering (where a genetic "cassette" manipulated in vitro and containing a recombinant DNA gene for a desired trait is inserted into the organism) and marker assisted breeding (where the use of known "marker" sequences associated with a desired trait are used to determine if the desired trait is inherited in offspring from conventional breeding).

The new techniques of genetic engineering and marker assisted selection have yet to result in improved cultivars with higher yields and other quantitative traits controlled by many genes simultaneously. The current seed varieties available in NAE for most crops, including those for increased yield, have been developed largely through conventional breeding where plants with desired traits are cross-bred and the resultant offspring contain the desired trait. Commercial hybrids are produced by the conventional breeding of two carefully chosen different high-quality true-breeding parental lines to yield progeny that themselves do not breed true, but that in combination give good yield (show vigor) and exhibit superior qualities, above those of traditional (open pollinated) varieties.

Hybrid varieties generally have increased vigor over their open-pollinated counterparts. With the growth of mechanization of agriculture, hybrids could provide uniform characteristics amenable to mechanical harvesting such as uniform maturity, concentrated fruit set etc., thereby increasing their attractiveness to and profitability for farmers. At the end of World War II, the emphasis was almost solely on yield, rather than nutritional quality because of food shortages in Europe. Later this trend continued because of the rise of processed food where uniform standards were required. This emphasis has remained until very recently with the advent of foods with additional or extra vitamins or minerals.

Between 1940 and 1960, new maize hybrids were developed by private companies such as the forerunners to Pioneer Hi-Bred (Troyer, 1999) that were suited to the application of nitrogen fertilizers. Between 1950 and 1980, the amount of nitrogen fertilizer applied to corn in the USA increased by a factor of 17 (Kloppenburg, 2004). Changes in plant architecture brought about by hybridization allowed these plants to be grown more densely with higher rates of fertilizer application and they were typically managed with the use of insecticides, fungicides and herbicides. Indeed, developments in crop protection have tended to parallel those in fertilizers.

Breeding with conventional techniques and biotechnologies has made considerable contributions to the development of non-cereal crops. The main targets for breeding have been agronomic properties such as crop pest and disease resistance and tolerances to biotic stresses (e.g. cold, heat, salt). Extending crop flavor, quality, nutritional characteristics, shelf life and seasonality are increasingly of importance in breeding programs for high value crops. Some breeding programs are even targeted at improving harvesting and transport. For vegetable cropping, quality has been the main driver of different breeding. There is currently renewed interest in breeding for resistance against pest and diseases in order to decrease pesticide inputs.

Mutagenesis

Radiation (usually gamma or x-ray) and certain chemicals have been used to induce mutations in plants as part of plant breeding for the past 50-60 years. Induced mutations are used to provide a general increase in genetic variation for use in plant breeding, or for the direct production of a variety with a certain characteristic. The techniques have been applied to almost all crops. Seed producing crops form the majority of new varieties produced through mutagenesis, but varieties of crops that can be reproduced vegetatively (e.g. the banana, trees, ornamental flowers) have also been developed (Ahloowalia et al., 2004). Mutagenesis has unpredictable effects and after exposure, plants must be grown to see if any useful mutants result that can be multiplied and developed as distinct varieties or used in plant breeding.

Mutagenesis is reported to have resulted in the production of 2,252 varieties according to the FAO /IAEA mutation varieties database up to the end of 2000 (Maluszynski et al., 2000). It has been increasingly applied to ornamental plants and flowers. One factor favoring the use of induced mutants has been the lack of intellectual property restrictions on access for use in cross breeding programs. One of the highest profile uses of mutagensis in plant breeding in recent years has been in the production of non-GE herbicide tolerant crops, e.g. for imidazolinone tolerance.

Marker assisted selection

DNA knowledge-based techniques, such as marker-assisted selection (MAS) and genetic engineering, rely on genomic characteristics and mapping and have shown great promise over the past few years (Asíns, 2002). This is especially true for complex characteristics such as drought resistance that tend to be controlled by multiple genes and hence are not amenable to straight-forward genetic engineering strategies. Furthermore, plants produced using MAS are considered conventionally bred in the US and Europe and are not subject to the same consumer and safety concerns raised with respect to GE crops, although in Canada they are regulated in the same manner. Marker assisted selection can be performed by private companies or public institutes as varieties would be protected by plant breeders rights.

Genetic Engineering

In NAE, only North America has embraced genetically engineered crops since 1996 (Fig. 2-11). Predominantly herbicide tolerant and/or insect resistant GE varieties of soybean, maize, cotton and canola are grown. For the most part, European acreage is limited to field trials of GE crops (ISAAA, 2005). GE crops producing novel compounds not intended for food use (industrial and pharmaceutical crops) are currently grown only in the US in small quantities and under strict management systems.

Insert Figure 2-11. Uptake of genetically engineered crops in the US

According to USDA's Agricultural and Resource Management Surveys (ARMS) conducted in 2001-2003, the majority of US farmers adopting GE corn, cotton and soybeans indicated that they did so mainly because of improved weed or pest control. Other reasons for adopting these varieties were to save management time, to make other practices easier and to decrease pesticide costs. The actual impact on farm income appears to vary from crop-to-crop; in some instances, management time savings have offered farm families the opportunity to generate more off-farm income (Fernandez-Cornejo and Caswell, 2006). In the EU, the total area of commercially grown GE crops is much less, accounting for only a few percent of the total maize harvest which is only grown for animal feed (GMO Compass, 2007). Regulatory differences and differences in public attitudes towards GE are the keys to understanding the different patterns of growth and are discussed later in this section.

<u>Changes in the organizational arrangements of seeds and genetics</u>

Plant breeders turned to new genetic techniques for a variety of reasons, including major emphasis on increased production and productivity in the political arena across the whole of NAE [.f. discussion of political emphasis on demand in Eastern Europe (Medvedev, 1987)] as well as through market demand. Moreover, efficient and well-financed knowledge transfer systems (e.g. extension and private consultants) moved these new plant breeding technologies and techniques into widespread use. In addition, plant breeders were responding to the larger scientific arena that was pushing knowledge boundaries.

Such major transformations in technologies and techniques were accompanied by significant changes in the organizational arrangements of seeds and genetics. Even as hybrid maize was developed by public institutes such as USDA in the 1920s, it became clear that there was an economic dimension to their development (Kloppenburg, 1991). Because the grain harvested from hybrid plants cannot produce economically viable seed, the seed has to be brought each year by the farmer. This contrasts with open pollinated varieties where seeds can be saved from year-to year. Thus, the seed business developed from a public service to a profitable industry

(Fernandez-Cornejo, 2004). At the same time, the number of varieties researched, developed and produced by public institutes waned.

A major driver of the shift from public to private research was the establishment of Plant Breeders' Rights (PBR). PBR are granted to the breeder of a new variety of plant to grant the control of the seed of a new variety and the right to collect royalties for a number of years. For several of the main commodity crops, farmers cannot sell the seed they produce but can use their own crops as seed. In 1961, the International Convention for the Protection of New Varieties of Plants, which restricted the sale of propagated protected varieties, was signed. Within Western Europe and the United States, national legislation was passed in the 1960s and early 1970s in accordance with the Convention. The WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) and The International Union for the Protection of New Varieties of Plants regulate plant breeders' rights internationally.

The legislation concerning plant breeders' rights was intended to stimulate private investment in producing new varieties. It certainly has done this but some maintain that there is conflict between these international agreements on plant breeders' rights and the Convention on Biological Diversity which advocates "fair and equitable sharing of the benefits arising out of the utilization of genetic resources. This has led to considerable continued discussion in a number of international forums. These uncertainties affect farmer practice and farmer profitability; clarification will be important for farmers in poor parts of the world to maintain profitability. The latter is important as the development of plant breeding techniques within NAE has had significant impacts on the rest of the world, particularly as many of these techniques and their resulting products have been transferred globally.

The way GE crops have been introduced into farming in NAE has in part depended on changes within agrochemical and seed industries. In the mid-1980s a new 'technological trajectory' based on biotechnology began to emerge for the agrochemical and seed industries (Parayil, 2003; Chataway et al., 2004). Regulatory pressures, which made it more challenging and costly to bring new chemical based products to market, and the existence of new science and a willingness on the part of industries to engage in large-scale change meant that biotechnology was adopted in research and development in a radical way (Chataway et al., 2004). However, the nature of change was such that adoption of new biotechnology based techniques (predominantly genetic manipulation) initially contributed to strengthening firms' abilities to produce chemicals rather than biotechnology-based alternatives to chemicals. Most multinational agrochemical companies used biotechnology to speed up the screening process for agrochemicals and to improve its efficiency and targeting (Steinrucken and Hermann, 2000). Biotechnology is closely related to changed developments in pharmaceuticals (Malerba and Orsenigo, 2002) and relates to three main areas:

- Using genomics to validate targets for new pesticides;
- Using combinatorial chemistry to generate large numbers of new chemicals for screening; and
- Using high throughput screening to test very large numbers of chemicals, rapidly on a range of living targets.

These new methods are unlikely to increase the number of new chemical products reaching the market but they are expected to allow companies to meet increasingly stringent regulatory requirements while still launching one or two major new products a year (Tait et al., 2000)

The development of genetically engineered crops is not entirely within the private sector in NAE; two examples thus far of publicly developed GE crops that have been commercialized or are undergoing regulatory review are virus resistant papaya and virus resistant plum (AGBIOS, 2008).

A key feature of the early evolution of biotechnology were efforts to create a 'life sciences' based industrial sector. Negative public opinion is one factor that affected these plans. The concept of life science synergies played an important part in agrochemical and biotechnology industry managers' strategic planning (Tait et al., 2000). Early interpretations of the term 'life science' assumed that, by using biotechnology to gain a better understanding of the functioning of cells across a wide spectrum of species, there would be useful cross-fertilization of ideas between the development of new drugs and of new crop protection products for agriculture. The vision was one of synergy at 'discovery' level, where a better understanding of genomics and cell processes, made possible by fundamental knowledge gained in the life sciences can lead to new drugs, new pesticides, GE crops and genetic treatments for disease.

These assumptions were accepted without much questioning until the very early years of the 21st century, partly to justify the continued retention within the same multinational company of two sectors with markedly different profit potentials, pharmaceuticals and agrochemicals. However, the original conception of a life science sector is now being reinterpreted. The synergy worked well where both partners are interested in sources of *chemical* novelty, but not in the *gene* area. The large scale marketing of genetically engineered organisms is not a significant factor in the strategies of pharmaceutical companies. Although experience in the USA and other countries has indicated that GE crop development is potentially very profitable, the negative public reaction in Europe has created potential conflicts of interest between the two industry sectors (Tait et al., 2000).

Over a medium and longer term timescale useful synergies between pharmaceutical and agricultural areas of biotechnology may again emerge, for example genetically engineered pharmaceutical crops. However, it is not clear that a link between the agrochemical and pharmaceutical divisions of companies will be maintained (Tait et al., 2000) and this could influence the direction on agriculture related science, technology and innovation. GE crops producing novel compounds not intended for food use (industrial and pharmaceutical crops) are currently grown only in the United States in small quantities and under strict management systems. Under these conditions, no ecological impacts have been detected.

It is clear that the development of important new technologies in plant breeding (i.e. hybridization, embryo transfer, genetic engineering etc.) has significantly increased productivity of cropping systems in NAE. Moreover, the shift from public institutions to private industry in the development of new varieties and technologies in plant breeding has had considerable impact on the development of cropping systems across the region. Where new technologies and products were developed that could be protected through IPR, industry consolidation has tended to occur. Many firms combined to take advantage of strong demand complementarities between products (Just and Hueth, 1993). This industrial concentration may create efficiencies but it may also limit the technological options as smaller firms which often bring dynamism to a sector find it harder to compete at the level of bringing products to market. However, they often arrange collaborations with larger firms in which they bring initial innovative research to a company with greater resources for product development and deployment. Similar arrangements are increasingly common between researchers in academia and large firms as well.

2.4.3.3 Nutrients in cropping systems

The productivity of agricultural crops draws on three primary sources: carbon dioxide from the atmosphere, and water and nutrients from the soil. While carbon is replenished by the atmosphere, continuous harvest of plant material can eventually strip reactive nitrogen (N), potassium (K) and phosphorus (P) from the soils impeding further plant growth. Agricultural production can also be limited by minor nutrient deficiencies, but N, P and K are the main limiting factors for production. Hence these are the main nutrients are augmented through synthetic fertilization.

Traditional fertilizers were organic manures, but by the early to mid 1900s the use of inorganic sources of P, mined from phosphate rocks and reactive N produced by industrial processes came into agricultural use as a result of the development of the Haber-Bosch process in 1910. After the end of World War II the use of synthetic fertilizers increased dramatically as a result of the breeding of new varieties able to respond to the increased fertilizer levels. The trends for NAE are similar to the world as a whole. Between 1950 and 1972 the supply of NPK fertilizers to Soviet agriculture increased almost 10 times and the rate of NPK application increased from 7.3 to 55.9 kg/ha per year (Narodnoe khoziaistvo, 1975) but there was a significant temporary decrease in fertilizer use in the CEE and CIS countries in the late 1980s due to the collapse of the former Soviet Union. While P use leveled off in North America around 1980, N use is still increasing, though at a slower rate than pre-1980 (Figures 2-12 and 2-13). Fertilizer use in the intensive cropping systems of the NAE is partly responsible for the considerable gains in agricultural productivity in NAE since the 1950s. Until recently, fertilizer has been relatively cheap for farmers and the profits from yield increases achieved far exceeded the costs of the additional fertilizers.

Insert Figure 2-12. Fertilizer use in North America

Insert Figure 2-13. Nitrogen and phosphorus fertilizer use in Europe and the Baltic States

2.4.3.4 Pesticide usage in NAE cropping systems

Synthetic chemical pesticides were developed and introduced after 1945 and have since become the major form of pest management in agriculture and stored products in NAE. The term pesticide refers to herbicides, insecticides and fungicides, as well as products that control rodents, nematodes and other pests and treat or preserve timber. Over 1000 chemicals are marketed worldwide, sold in tens of thousands of formulations (Tomlin, 2006).

A program for registration of pesticides was initiated in 1947 by the US Department of Agriculture and is currently under the authority of the US Environment Protection Agency (Pierzynski et al., 2000). All NAE countries now have stringent requirements for the registration of pesticides, which authorize specific formulations for each crop and require evidence of tests on non-target organisms, fate and transport of pesticides. Data requirements have progressively increased to address environmental and health concerns. The organochlorine pesticides which represented the first generation of insecticides were bioaccumulative and environmentally persistent. This led to a series of bans and withdrawals in NAE and worldwide. In 1960, chlorinated pesticides had represented about 75% of insecticide use in the US, but by 1997 these were less than 3% (see Aspelin, 2003). Nine of these insecticides are now scheduled to be withdrawn from production and use under the Stockholm Convention on Persistent Organic Pollutants. Since 1992, discussions have taken place to globally harmonize the classification and labeling requirements for pesticides worldwide (OECD, 20xx).

Synthetic chemical pesticides did not become available after 1945; massive increases in use were recorded in NAE from 1950 onwards. Trends in use by volume in the USA (Fig. 2-14) are also similar to Western Europe, showing a peak in the 1980s. Measurement by volume use is a limited indicator of pesticide use and change, as it amalgamates information on products used in undiluted form, reflects neither their toxicity to different organisms nor their persistence in the environment and masks the fact that newer pesticides are developed to be more active at lower rates of application. In 1997 approximately 350,000 tonnes (USA), 32,000 tonnes (UK) and 100,000 tonnes (France) of pesticides were used on agricultural crops (FAOSTAT, 2006).

Detailed changes at country level are difficult to access, but an example from UK national pesticide survey data demonstrates large increases in land area treated with fungicides and herbicides between 1974 and 2002. Increases arise from multiple treatments on cropped areas as the area sown remained relatively static. The number of pesticide treatments applied per hectare per year increased from two to nearly nine (Chapman et al*.,* 1977; Davis et al*.,* 1990; Garthwaite et al*.,* 1996, 2000, 2004; Sly, 1977, 1986). In the US, where agriculture typically encompasses 75 to 80% of total use of conventional pesticides, the growth of pesticide use through the 1950s and 1960s was primarily due to the greater application of herbicides (Kiely et al., 2004). Herbicide use peaked around 1980, with atrazine being the most used active ingredient for many years, but by 2001 it was overtaken by glyphosate as a result of the wide adoption of glyphosate-tolerant crops. Most US producers of major crops now scout for damaging insects (NASS, 2006) and only apply insecticides when the defined thresholds are exceeded and when the projected savings from yield loss will outweigh the costs of the insecticide application. Some of the decrease since 1995 is due to the use of genetically-engineered insect resistant varieties of maize and cotton (Fernandez-Cornejo and Caswell, 2006). Integrated pest management techniques are increasingly adopted and can make a significant contribution in the general reduction of insecticide use (Kogan, 1998)

Insert Figure 2-14. Trends in pesticide use in the USA

A number of NAE governments have promoted programs to reduce pesticide use. A Canadian government program, Food Systems 2002, was launched in 1987 to reduce the use of pesticides in agriculture by 50% by the year 2002 (Gallivan et al., 2001) and achieved a 38.5% reduction 1983-1998. The decrease came partly from smaller cropping areas, but principally from reduction in mean application rates. In the EU, a number of countries, including in Denmark, Germany, the Netherlands and Sweden, have adopted legislation to reduce pesticide use and reductions have been achieved, partly by the use of newer products with lower environmental footprint. The European Commission (2002) is now requiring countries to develop pesticide reduction strategies.

Role of AKST

The development of pesticides has depended almost totally on scientific advances in the private sector. The majority of pesticides have been produced by multinational agrochemical companies. Research by universities and public agencies (such as US Geological Survey) has improved understanding of the fate and transport of agricultural pesticides and the impacts on drinking and groundwater (Schraer et al., 2000; Thurman and Aga, 2001; Spaulding et al., 2003).

The public sector has played a greater role in the regulatory approval for pesticides for minor or specialty crops where the small markets are not large enough to warrant conducting the necessary field tests. Science and technology have also played a role in governmental regulation, as new tools and techniques, coupled with increased understanding of environmental consequences, have led to increasingly rigorous evaluation of new products. In the US the number of new pesticides being registered that are classified as low-risk and biopesticides (naturally occurring compounds) are now greater than the number of new conventional pesticides, but they remain a small proportion of the available pesticides (EPA, 2005). Agricultural science has provided tools to develop biological control agents and other non-chemical methods.

The drivers of pesticide use in the NAE have been:

- the objective of increasing crop yield and quality;
- the demand from NAE markets for pest- and disease-free products leading to greater use of pesticides in almost all crops and horticultural crops in particular; and
- the rise of related environmental concerns among regulators and the general public resulting in greater regulation of pesticides and restrictions on use. A specific aspect of this has been the need to reduce levels of pesticides in both ground and surface waters and to minimize residue levels in food.

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2.4.3.5 Water control in NAE cropping systems

Soil moisture in agriculture has a large impact on yield and plant health. Root growth and function is impaired if soils are either waterlogged or droughted and this in turn affects the vigor of the plant above ground.

As many lowland soils are naturally waterlogged, especially during spring and fall, farmers have often drained their land with subsurface drains that are highly effective at removing water from large areas of land. The fired clay was expensive and installation was labor-intensive so 19402 era drainage pipes were replaced with machine laid plastic pipes in the 1950s (Spoor and Leeds-Harrison, 1997). Large subsidies were made available to farmers to encourage soil drainage and from 1950 to 1990 vast areas were drained (c.f. Robinson and Armstrong, 1988 for a UK example), improving crop yields and increasing access to land for spring planting and harvesting at the end of the season. Access to land in fall also opened up the potential for winter cropping, which is now common over large parts of Europe and the US. While drainage on this scale certainly improved yields it also gave rise to serious water pollution problems due to oxidation of iron and sulphur compounds in soils and increased nutrient and pesticide run-off to rivers and streams (Sagardoy, 1993; EEG, 1994; Ongley, 1996; FAO, 1997) (see Chapter 3 for discussion of environmental impacts of irrigation).

In NAE irrigation is used extensively in southern Europe and the western United States. Much of this use focuses on high value horticultural crops, although there is also appreciable usage in some of the major arable crops such as maize, soybeans and potatoes. Overall, within the EU (15), there has been a rise in the percentage of irrigated crops from 4 to 9% over the last forty years (source FAOSTAT, AQUASTAT). This average value disguises the greater areas irrigated in the hotter southern countries and the much lower usage further north. In the United States, the area under irrigation doubled between 1949 and 1979 to 21 million hectares and by 1987 had more than doubled again (Rhoades, 1990a). Although irrigated land is only 18% of the total harvested cropland, farms with irrigated land receive 60% of the total market value of crops in the United States (USDA, 2004). Irrigation not only increases crop value, it can also increase water use efficiency (Howell, 2001) by increasing the mass of crop produced per volume of water.

A major challenge for irrigated agriculture is increasing competition for water, primarily due to population increase (NRC, 1996). As a result of this irrigation cost will increase (CAST, 1996); already the average irrigation application rate has declined from 1080 ha-mm per ha (3.55 acre-ft per acre) in 1950 to 756 ha-mm per ha (2.48 acre-ft per acre) in 2000.

The desire for increased productivity has been a major driver increasing the use of irrigation in the NAE, along with an increasing demand for products outside their normal production period (especially for fruits and vegetables) and the increased profitability of crop production using irrigation methods.

2.4.4 Agricultural products for energy and fuels

Due to a rapidly growing interest in developing alternate fuels for transportation, expectations are high for agriculture to produce liquid biofuels. The US Energy Policy Act of 2005 calls for the use 7.5 billion gallons per year (equivalent to 2% of the US gasoline consumption) of biofuel (primarily ethanol) to be mixed into the US fuel supply by 2012. The European Union biofuels directive of 2003 sets a reference value of 5.75% for the market share of biofuels in 2010.

In the US, ethanol production capacity has increased from 1.6 billion gallons per year in 2000 to about 5 billion gallons per year in 2006, with an additional 6 billion gallon capacity under construction (Renewable Fuels Association, 2006). Biodiesel production (primarily using soybean as a feedstock) is currently much lower than ethanol, but rapidly expanding. As of 2005, there were 53 biodiesel plants with a capacity of 354 million gallons per year. Biodiesel capacity is expected to reach 1.2 billion gallons per year.

As in North America, production of biofuels is increasing in some parts of Europe. Little was produced prior to 2000 but by 2004 biofuel production had reached 2.4 M tonnes and the aim is to produce 18 M tonnes by 2010 (EU Commission, 2006). Unlike the USA, most biofuel in Europe is biodiesel from oilseed rape and in 2004 2 M tonnes were produced. Assuming an average yield of 2.5 tonnes ha^{-1} this amount of biodiesel would have been produced by about 300,000 ha of oilseed rape. The remainder of the biofuel production was bioethanol, much of it derived from excess wine production in the EU.

Increased biofuel production can increase the price for the crops at the farm gate and provide more price stability. In addition, the biofuel industry can provide off-farm, rural employment opportunities while the byproducts of biofuel production (distilled grains and residue after oil is recovered) are considered quality feed supplements.

However, there are clearly limits as to how much biofuel can be produced, at least with current and foreseeable technologies. For example, in 2005, 14% of the US corn crop was used to produce the equivalent of 2% of gasoline use in the US (by energy content). By comparison, the US exports about 16% of its corn production. Using the same corn use to ethanol ratio, utilization of 100% of the US corn crop for ethanol would produce fuel to replace only about 14% of the US (2005) gasoline use.

While at least at a modest scale, biofuels production should benefit the NAE agricultural community, questions remain whether greatly increased production and use of biofuels will have detrimental environmental effects, or even meet the projected environmental benefits. To the extent that mandates to meet certain biofuel use targets cannot be met by domestic production, biofuels will need to be imported. This may negate some of the savings expected from import of petroleum products. Further, it may prompt increases in agricultural production elsewhere at detriment to the environment (e.g. Pearce, 2005).

One incentive for the use of biofuels is their replacement for fossil fuels. There are some estimates that the current production of biofuels is actually carbon negative in that it takes more fossil fuel to produce biofuel than the petroleum it is intended to replace (e.g. Pimentel and Patzek, 2005) though others point to a positive net carbon balance in the production and use of biofuels (e.g. Farrell et al., 2006; Worldwatch, 2006). Biofuels could be used to replace the fossil fuels in the agricultural practices to produce biofuels.

Other agricultural-related energy sources

Agricultural lands may make a contribution to energy in ways other than through production agriculture. For example, in the US the richest wind energy resource, available in wide areas, stretches from the upper Midwestern plain states to Texas (Elliot et al., 1986). Farmers have leased the land for turbines, or have invested directly in their ownership. The potential of the Midwest wind resource has been recognized and the number of installed wind turbines and overall electricity production capacity is expanding (c.f. Wind Energy Association, http://www.windustry.org/default.htm; US Dep. Energy, 2007).

Forestry and other sources of plant material (e.g., biomass crops) are being increasingly used in Europe as a source of heat and energy, driven by the rising price of oil. In 2004 52.4 M tonnes (oil equivalent) were produced from these sources. A huge proportion of this was from forestry waste, especially in the well forested EU states, such as those in Scandinavia. However, the EU propose to greatly increase the 2% of energy from biomass crops such as coppice willow and Miscanthus grass, so that it makes an appreciable contribution to the EU energy budget in the future (EC, 2005, 2007). As in the USA there are also considerable developments in the utilization of wind power. In 2004 the EU contributed 73% of the world's total capacity of 48 thousand MW. There is much debate as to the location of these wind farms and of their environmental impact, but they do offer an alternative source of income to farmers and other land owners.

2.4.5 Organic cropping systems

Largely unidentified as organic before the advent of synthetic fertilizers and pesticides, organic agriculture has been one response to public concern over the environmental and health impacts of industrialized agriculture. Since the beginning of the 1990s, organic farming has rapidly developed in almost all European countries. Growth has slowed recently. In 2004 in Europe, 6.5 million hectares were managed organically on about 167,000 farms. In the European Union more than 5.8 million hectares are under organic management and there are almost 140,000 organic farms. The country with the highest number of farms and the largest organic area is Italy. In most countries of Europe and particularly the European Union organic farming is supported with legislation and direct payments. In terms of the share of organic farmland to total agricultural area, Austria, Switzerland and Scandinavian countries lead the way. In Switzerland, for example, more than 10% of the agricultural land is managed organically (Willer and Yussefi, 2007). In fact the land under the organic certification has been largely increasing since 1994, i.e. when financial support was first introduced by the EU-Regulation 92/2078.

The support for organic production granted by the reform of the CAP, i.e. enforcement of the EU Regulation 2078/92 (mis.A3+A4), constituted a fundamental step in this evolution and largely promoted the conversion to organic farming in the Southern regions of the EU, even though the pioneers of organic agriculture were in North and in Central Europe. In the 1990s, regions in the south of Italy recorded the highest rates of growth of farms in conversion to organic farming. In the European Union, the European Organic Action Plan implementation process is now getting under way (Miele and Pinducciu, 2001).

In North America almost 1.4 million hectares are managed organically, representing approximately a 0.3% share of the total agricultural area. Currently, the number of organic farms is almost 12,000 (Willer and Yussefi, 2007). With the adoption of national standards in 2002 in the United States, the organic sector has been able to provide a guarantee to consumers that organic products using the labeling followed specific practices. The US market has been growing rapidly, estimated by the Organic Trade Association at 20% or more per year, with a growing number of certification agencies accredited by USDA and talks progressing to expedite international trade of organic products. Since 1999, the Canadian industry has had a voluntary Canada Organic Standard that is not supported by regulation. The organic industry continues to devote its energies toward implementation of a mandatory national organic regulation to help expedite trade relations with such major trading partners as the United States, European Union and Japan.

2.4.6 Key changes in cropping systems and drivers

In summary, production of arable crops has doubled and in some cases tripled over the last 50 years in the NAE. These production increases have been mainly due to increases in output per unit area, as the area of arable land in the NAE has not increased and in many countries has decreased slightly. Production increases have been facilitated by the contribution of AKST, providing farmers with new tools to enhance crop production. These have primarily been more efficient use of fertilizers, mechanization and development of novel more effective agrochemicals and the breeding of new higher yielding cultivars.

Dissemination of this new knowledge has depended on the development of efficient knowledge transfer systems, both governmental and private sector. Moreover, there has been increased technological sophistication in agricultural mechanization. The increased productivity/efficiency of cropping systems has left more time for off-farm employment and decreased labor employment in agriculture. Despite the labor savings brought about by mechanization in many agricultural systems, some production systems remain labor-intensive (e.g. horticultural crops).

New tools enabled change or extension of farming practice. For example, larger field sizes to accommodate machinery, new areas under cultivation because of improved plough/cultivation capability, increased capability for minimum tillage, increased ability to cope with management and feeding of livestock at higher densities, shift from silage to hay. However, there are also negative aspects associated with soil compaction and structural damage resulting from frequent passes of large heavy machinery. Still, mechanization has increased the practicality of the production of some organic crops (e.g. new innovations in mechanical weeders).

2.5 Changes in Livestock Systems in NAE

As in cropping systems, the key change in livestock systems in NAE has been significant increase in both productivity and production of meat and dairy products driven by an increased demand for these products among NAE consumers. This has been made possible by improved genetics and widespread access to superior genotypes, changes in livestock feeding regimes, development of specialized production units for livestock and improvements in food safety. Consumer demand for humanely treated livestock and increased concern about environmental impacts of intensive livestock production have started to change production practices across NAE, especially in Western Europe.

Because of World War II’s disruptions to production, distribution and storage, the postwar livestock industry could not meet European consumer demand until the late 1950s. Meat consumption per capita has generally increased since post-war rationing ended (Aumaitre and Boyazoglu, 2000). During the post-war years most European governments used subsidies to increase livestock production (Hodges, 1999).

Mixed farms such as those in Europe where livestock was fed mainly by grazing or cereals produced on the same farm predominated after WWII. In this period, the US had a geographically dispersed livestock sector. On the uplands in Europe, pastoralism was a way of life using summer grazing and winter stock movements (‘transhumance’) developed in mediaeval times.

In Europe, the mixed farms of the 1940s have today almost completely changed to either specialist arable or milk and livestock production units, using high intensity production methods promoted by the CAP and state subsidies of capital investment and/or productivity-related payments (de Haan et al., 1997). Half of all EU farms still have livestock, with 90% now specialist livestock producers, buying feed from global commodity markets (European Commission).

Europe now has one of the highest livestock densities in the world (FAOSTAT), with a mixture of intensive grazing and fattening/rearing units where livestock are fed on both home-grown and imported feed. The overall result has been increased livestock numbers (although the livestock density (LU/ha) in Europe has fallen some 10% in the past decade (FAOSTAT) and increased productivity of all livestock and dairy products, leading to large-scale over-production in the cattle, pig and poultry sectors over the past twenty years.

US and Canadian livestock sectors have also undergone extensive restructuring since 1945, but in different ways (Table 2-7). One of the key developments has been the integration of the US, Canadian and Mexican livestock sector, accelerated by the adoption of NAFTA in 1994. This is particularly true in the beef and pork sectors (Farm Foundation, 2004; Haley, 2004; Young and Marsh, 1998). Prices for beef and pork tend to move together in both wholesale and live animal markets, particularly in Canada and the US (Vollrath and Hallahan, 2006) (e.g. 8% of pork slaughtered in the US now originates in Canada, a large increase over the last decade (Hahn et al., 2005). Poultry is the exception as it is not as well-integrated because it is a managed sector in Canada.

Insert Table 2-7. Change in livestock farming operations in NA.

As in Europe, the number of farms in North America with livestock has decreased (McBride, 1997), while production of red meat, poultry products and dairy products has continued to increase. In the US, there have been significant geographic concentrations in beef and broiler production. Large feedlot operations for beef are concentrated in the Great Plains, while broiler production is heavily concentrated in the Southeast. In the 1980s hog production shifted from the Midwest to large operations in the Southeast (Figure 2-15; Welsh et al., 2003). At the same time, dairy production expanded in Western states away from the Northeast and Upper Midwest (McBride, 1997). Canada has seen similar geographic concentrations of livestock production with hog production shifting from Quebec and Ontario to the west, particularly Manitoba, while cattle production has become concentrated in Alberta (USDA-FAS, 1996).

Insert Figure 2-15. Geographic changes in hog and pig production in the U.S

2.5.1 Trends in output and productivity since 1945

Four groups of animals produce over 90% of Europe's meat and dairy products; cattle for milk, beef and veal, pigs for meat, poultry for meat and eggs and sheep and goats for meat, milk and wool. Meat, dairy products and eggs account for over one-third of the total value of agricultural production in Europe. Beef sales declined during the BSE crisis from 1996 to 2001 but have now begun to recover (Morgan, 2001; USDA, 2005). Pig and poultry meat consumption increased due to the BSE-induced dip in beef demand, but have increased even further since the 1990s due to greater competitiveness with other meat production, partly as a result of CAP reforms that made cheaper cereals available for animal feed. Sheep meat production and consumption declined during the 2001 UK foot-and-mouth disease outbreak, but have now almost recovered (Eurostat Agriculture, 2007a).

In response to growing demand from a larger and richer population, production of all livestock increased very rapidly in the EU-15 from 1961 to 2000, while production of meat and dairy products has fallen in CEE from 1990, mainly as a result of the transition from a centrally planned to a market economy. However in Hungary, Slovenia, Croatia and Romania production has either remained stable or increased slightly from 1993 to 2004 (EU 2004). Europe (EU-25) produces over three times as much meat per head of human population as the world average of 36 kg per capita (FAOSTAT, 2007a).

This productivity has led to over-production. Europe is more than self-sufficient in meat, with a current net balance of around 105% for all meats (Eurostat Agriculture, 2007a). As a result of rigorous CAP reforms in the 1990s, European production of beef and veal has fallen rapidly from around 50% over-production (EU-15) in the 1990s to around 96% self-sufficiency in 2004. Beef and veal consumption has risen in the past 4 years, with the European production deficit being made up by imports of around 250,000 tonnes per year from South America. Pig meat is still being over-produced in EU-25 by about 8%, making the EU-25 a net exporter of pig meat products, mainly to Russia and Japan.

The EU is a net importer of sheep meat (EU-25 is only 78% self-sufficient in sheep and goat meat) and dairy products, mostly from New Zealand and also imports large quantities of poultry meat from Brazil and Thailand, where production costs are much lower than in Europe. Somewhat perversely the EU also exports large quantities of poultry meat and offal to Russia and the Ukraine and parts of the Middle East (Eurostat Agricultural Trade Statistics data).

North America accounts for 16% of the world's total number of beef cows, 8% of the world's pig crop, nearly one-third of the world's poultry meat production and nearly 15% of the world's milk (Farm Foundation, 2004; Adcock et al., 2006). In the swine sector, productivity in breeding herds has increased significantly, with 3.2 million fewer sows in 2004 than in 1980 producing roughly the same amount of pigs. The US and Canada have been able to increase milk output 19% (Figure 2-16) and 6% respectively, even with fewer cows, due to significant improvements in milk productivity related to improved genetics (Farm Foundation, 2004). In the US the value of livestock production increased nearly by a factor of eight between 1948 and 2005, while the production of red meat increased nearly 50% from 1963 to 2006 (even though lamb and mutton production has declined sharply due to cheaper imports). Poultry production has also significantly increased.

Insert Figure 2-16. Trends in productivity per cow in US from 1996-2005.

In Canada, pig slaughter has nearly tripled since 1976, while cattle slaughter declined and then started to increase in the last 15 years, due to the opening of new processing facilities by US based firms, Cargill and Tyson. Sheep and lamb slaughter, while still very small has managed to almost double since 1976 a very different trend than the US.

Overall, livestock productivity and output in NAE has increased enormously since 1945 with beef, pig meat and milk production almost doubling and a four-fold increase in numbers of poultry. Sheep and goat numbers and production of meats and other products from this animal stock have remained comparatively stable (data compiled from FAO, Eurostat and USDA).

2.5.2 Drivers of increased livestock output and productivity

The spectacular rises in livestock numbers and productivity seen in NAE over the past 50 years result from six major drivers:

- Growth in population numbers and wealth, creating strong market demand for meat and dairy products (for example in dairy products a 1% growth in income gives almost the same increase in consumption in low income countries and about 0.35% increase in wealthy countries (Agra/CEAS, 2004);
- Strong policies and strategic frameworks within NAE aimed at increasing livestock production;
- Rules and regulations determining husbandry methods and processing of livestock products;
- Production-led subsidies that funded output and productivity increases (Starmer and Wise, 2007);
- The application of knowledge, science and technology to animal genetics and nutrition, including grassland management and feed formulation; and
- Improvements in animal and livestock product transport systems allowing animal production and slaughter to be situated more closely to major supplies of feed.

The most important contributors of AKST to increased productivity have been changes in livestock genetics, livestock feeding and stock management systems. For example, selection involved in animal breeding took place at the farm level until the end of the 19th Century resulting in the adaptation of cattle, pigs, sheep, goats and poultry to specific (usually regional) farming and market situations (Hodges, 1999). Yield goals were blended with emphasis on selecting livestock that would thrive on particular types of land, climate and feed (CIV website).

By contrast, in the 20th Century livestock breeding was increasingly done in either state-owned or private institutions using genetic science. Coupled with advances in land and management practices such as drainage, fertilizer use and better harvest and storage techniques, these breeding programs began to be more yield-oriented to cope with increased demands for food from a rapidly expanding urban population in Europe and desire for more meat consumption among North Americans. This drive for greater productivity accelerated in the 1950s as a response to the need to rebuild the food supply chain after World War II. Science-based livestock breeding typically produced annual genetic changes of around 2% of the mean of a trait (or trait-related index), especially in species with high reproductive rates like pigs and poultry (Simm et al., 2005). Not only were yields from livestock varieties substantially increased, but standardized livestock systems were also developed where in cattle (and to some extent sheep), the landscape was adapted to the system. In pigs and poultry, the whole enterprise was taken off the land and into intensive housing and feeding systems. Varieties that maximized food conversion ratios were quickly developed, especially in pigs and poultry (Simm et al., 2005), with cattle breeding focused almost entirely on high milk and meat production. In N. America in the 1960s and 1970s, the so-called “British Breeds” of cattle were replaced in much of the beef sector by “Continental Breeds” that introduced size and leanness, in response to consumer desire for leaner beef. The genetic techniques used to achieve these productivity gains include:

- Better statistical methods of estimating the breeding value of animals
- The use of artificial insemination that allowed producers at any level to access superior genetics
- Better techniques for measuring performance of new breeds
- Selection focused on quantitative traits, such as weight gain and disease resistance

Despite the undoubted success of these science-based breeding programs, it is generally agreed that the maximum genetic potential of cattle, pigs and poultry has still not been reached and intensive breeding programs are still maintained in Europe although the focus is now shifting away from continued productivity increases towards animal health and welfare traits (Garnsworthy, 2005).

As a result of these breeding and husbandry techniques, the wide variety of landraces in 1945 was quickly replaced by a few high yielding varieties, such as Holstein/Friesian milking cattle (e.g.

this breed comprised more than 85% of the Canadian dairy herd in 1999 (Kemp, 2001) or white lines of pigs used in intensive production facilities. Most livestock landraces have survived in small numbers either by the activities of 'rare breed societies' who try to maintain the genetic base of the 'old' livestock breeds, or by being used to produce niche market high quality products, mainly meat and cheeses.

The latest developments in animal breeding include genetic engineering. Its use is unpopular in Europe , but in North America, ancillary uses of GE technology, e.g., to increase milk production through the administration of recombinant Bovine Somatotropin (rBST) has been widely adopted. Whether transgenic animals in the food supply are accepted by NAE consumers remains to be seen. In Europe, rBST use for milk production raised concerns about animal suffering and potential negative impacts on small farmers. In the context of surplus milk production in NAE, the benefits of this application continue to be debated.

Simultaneously with breeding for improved productivity, NAE scientists also focused on improving livestock feeding and management. For example, the weight gain for broilers at 56 days in 1957 was around 800g, compared to a 3900g weight gain in 2001 (Havenstein et al., 2003). Similar trends can be found for weight gain in pigs and for milk yields in cattle (Simm, 1998). Breeding and nutrition technologies for sheep and goats have not been subjected to such intensive scientific attention as they are still mainly raised on marginal land throughout Europe and the market is smaller.

Grassland-based cattle systems have changed radically throughout most of Northern and Western Europe from haymaking to silaging using the highest fertilizer inputs in the world (FAOSTAT), with great loss of non-grass biodiversity in pastures and meadows since WW2 (Johnson and Hope 2005). Haymaking with low fertilizer use still survives in upland and marginal areas in N and W Europe and in many parts of the CEE countries, especially where traditional breeds of livestock are used. Grasslands, particularly in western regions, have been the predominant system for cow-calf and sheep production in N. America. Because of increased environmental concerns about management of federal lands in the US, there has been renewed interest in range management. Intensive grazing systems are increasingly used in beef cow and dairy herds across NA, where the focus is on increasing profitability per animal, rather than maximizing productivity (Gerrish, 2004). In the future, increased demand for grain for biofuel production may increase costs of animal production, potentially increasing consumer prices to the point where supply of cheap livestock products is reduced in less wealthy parts of NAE.

A major change contributing to increased production and better storage has been in the vertical integration of the livestock chain through standardizing genetics, feeding systems and housing units while increasing communication throughout the sector. In N. America this is particularly apparent in the poultry and pork sectors and in Europe, high throughput automated housing, feeding, slaughtering and processing facilities have grown larger, replacing smaller family-owned businesses (European Commission, 2001). Across NAE, many animal production, slaughter and processing units are operated by large consortia which control large parts of the food chain, increasingly out-competing family farms by means of their economies of scale and ability to influence market prices for livestock and products.

Changes in Livestock and Labor

Changing consumer preferences and the meat industry's increased emphasis on pre-cut and pre-packaged meat and growing export levels increased the demand for labor. Between 1972 and 2001 employment in the poultry processing industry increased by 150% in the US, with jobs being on offer mainly as low-skilled manual labor. During this period re-structuring in the industry had led to a re-location of processing plants to rural areas, largely to areas which lacked an unionized tradition. With greater technological innovation, meat-processing has become increasingly de-skilled and in addition to stable or declining real wages meat processing employment became less appealing for increasingly well-educated native born workforce (Stull, 1994). The industry had undergone a gradual change from unionized urban skilled workforce to rural based mostly non-unionized and low skilled workforce concentrated in manufacturing plants by the 1980s and these characteristics have remained the same since that time (Kandel, 2006) Hispanics workers are over-represented within the food processing industries. Between 1980 and 2000 the proportion of Hispanic meat-processing workers increased from under 10% to almost 30% of the total. The Hispanic workforce during this period itself became mostly foreign born (Kandel, 2006) increasing from 50 to 82% of the Hispanic segment of the population in this period.

In the second part of the 20th century, major changes also took place in animal production facilities and investment in buildings and their use have become issues of growing importance for farmers and growers (Gay and Grisso, 2002). Traditional buildings associated with livestock production were general purpose, small scale and reflected production systems relying heavily on manual labor. Faced by rising labor costs, facilitated by a variety of technological developments in machinery, building materials and methods of controlling the environment, a major transformation has taken place where modern high throughput facilities, such as dairy parlors and pig and poultry production units, have largely replaced traditional multipurpose buildings. These provide controlled environments with measured use of feed and prophylactic treatments to prevent disease. Such facilities are also very important in the vertical integration of the meat supply chain.

A less evident contributor to productivity in the NAE livestock sector is the development of effective transport systems that allowed animal feeding and slaughter to be concentrated more closely to feed sources, particularly in beef production. A parallel process was the introduction of vacuum packaging in the late 1960s. This significantly altered the value chain for beef and other protein, since retailers could sell particular cuts of meat without an on-site butchery (Duewer, 1984).

These developments in genetics, management systems and meat handling, combined with the geographical shifts in production, allowed significant restructuring in the beef, pork and poultry sectors leading to the development of confined animal feeding operations, contractual relationships in marketing and specialization in livestock agriculture. These changes have been controversial because intensive livestock production raises ethical and environmental issues. Treating animals as items on a production line offends many NAE citizens who feel this is an unacceptable relationship between humans and other species. Farm animal welfare has become an important area for policy makers, especially in Europe (Webster, 2005). The mass production of animals to specification, while producing cheap and nutritious products, also undermines traditional livestock businesses, reducing local employment and undermining the economic survival of some communities. In an area in which emotions often play an important part in determining attitudes there are a wide range of pressure groups and consumers who criticize intensive livestock production. For example, the development of confined animal feeding operations in NA have resulted in significant conflicts over air and water quality, land use issues (zoning) and regulatory control (Bonanno and Constance, 2006; Donham et al., 2007; Heederick et al., 2007).

Livestock kept in intensive systems can be prone to outbreaks of disease, illustrated by the periodic outbreaks of foot and mouth disease and encephalopathies such as BSE and scrapie; viral diseases in cattle, sheep and pigs and epidemics of viral and bacterial poultry diseases. While epidemic disease has always been part of livestock production, the larger groups of animals and widespread transport to and from markets associated with intensive systems have increased risks of large epidemics, even though biosecurity at individual units has been improved (e.g. Defra, 2006; Colorado Dept of Agriculture, 2007). It has been argued that intensive systems have also produced new and dangerous diseases such as *E.coli 0157:H57* and BSE (FAO, 1998; Walker et al., 2005). These epidemics have sometimes devastated livestock sectors in Europe and have largely been controlled by a slaughter policy, although for some pig and poultry diseases vaccination and the routine use of antibiotics has become common practice since the 1950s. There is serious concern about the latter as growth promoters and disease control agents in NAE livestock production because of the rise of antibiotic resistant bacteria in humans (Khachatourians, 1998; Mellon, 2000).

Food safety issues are also important in the meat industry in North America. In 1995, an outbreak of *E coli 0157:H57* killed several children who had eaten fast food hamburgers in Washington state. This event led to a revolution in food safety procedures in red meat, seafood and poultry in the US with the creation and adoption of new food safety rules (see 2.8.4). Food safety concerns about *Salmonella* and *Listeria* continue to be of concern throughout the NAE livestock sector (Johnston, 2000; Rajic et al., 2007).

Advances in productivity in the NAE livestock sector would not have been possible without public investments in AKST. In particular, many new genetic selection techniques were developed through public university and disseminated through extension services. Today, much of the actual genetics has been privatized and is now maintained primarily in the private sector, although performance measures for stud selection are still provided in the public realm. In the same way, the research that developed the HACCP approach to food safety was performed by public entities like USDA-Agricultural Research Service and enforcement is still performed through USDA. Finally, many of the engineering advances that allowed the development of large-scale climate controlled buildings for poultry and swine and for handling the wastes of those systems, were developed in the public sector and disseminated widely.

2.5.3 Key changes in the NAE livestock sector

Livestock productivity and output in NAE has increased enormously since 1945 driven by policy (especially the CAP), government subsidies (Starmer and Wise, 2007) and increasing population and wealth. AKST has been a key driver of growth in the livestock sector and is likely to remain so in the future. Europe and North America have been exporters of livestock sector AKST to the rest of the world.

For the past 30 years much of NAE has been producing far more meat and dairy products than it needs with the EU and NAFTA blocks becoming some of the world's leading exporters, particularly in pork (EU), chicken and beef (NA). The search for more market sector has led to dumping of these products in less wealthy countries with consequent damage to the economic status of their agricultural producers. In common with the rest of the developed world, milk, beef, pig meat and poultry are among the most valuable agricultural commodities produced by European farmers (see FAO chart for 1985).

Much of European lowland and landless livestock production is the most intensive in the world and this has had serious adverse impacts on the European environment. Similar situations exist in N. America because of the increased geographical concentration of livestock production. Across NAE, livestock enterprises have become fewer and larger due to economies of scale and this trend is likely to continue especially in the CEE region of EU-25.

Developments in genetics, management systems and meat handling in NAE, combined with the geographical shifts in production, allowed significant restructuring in the beef, pork and poultry sectors leading to the development of confined animal feeding operations, contractual relationships in marketing and specialization in livestock agriculture.

Subsidy-led policies are moving away from production-led subsidies towards a more market-led and environmentally friendly system, but there still substantial direct and indirect subsidies paid to most livestock sectors that reduces the competitiveness of developing countries.

2.6 Changes in Forestry Systems

In North America and Europe, forests and woodlands have always been the dominant vegetation cover. NAE forests are largely derived from natural vegetation dominated by deciduous trees in the south and west and vast areas of conifers towards the north and east that make up over 50% of total forest cover.

NAE forests have been exploited by humans for timber supplies, fuel, food (e.g. nuts, fungi and berries), for cork (the EU is the largest producer of cork with over 80% of the world market) and for paper fiber, while still providing a significant proportion of the renewable energy used by both industrial and domestic consumers. Forests also provide valuable and irreplaceable ecosystem services such as water resource protection, biodiversity and carbon dioxide fixation (MA, 2005). For example, approximately 140,000 species of plants, animal and micro-organisms are estimated to occur in Canada of which approximately 2/3 are found in the forests (Canadian Forest Service, 2003).

2.6.1 Main trends in NAE forests and forestry production

NAE is the only world region where there has been an increase in forest area since the 1960s. In 1630, when conversion of North American forests to agricultural land began, 50% of US lands were forests. Today, forests are approximately 33%, but since the 1980s have been increasing by 0.3% per annum. The US growing stock volume increased 39% from 1953 to 2002. The 415 million ha of Canadian forests represent 10% of the world's forests, with 20% of the world's fresh water flowing from its watersheds. Forests cover 45% of the land mass of Canada (Lowe et al.,

1996) although it is unclear whether forest cover in Canada is stable or contracting (CANFI, 2004).

Forests in Europe have been expanding over the past 40 years by around 0.8% p.a., about 880,000 ha per year. This has been mainly due to an increase in plantations, reversion of agricultural land and decreased harvesting activity especially in the Russian Federation. The Russian Federation accounts for over 90% of an estimated 1.5m ha per year natural re-colonization of non-forest land in Europe (Kuusela 1994; TBFRA, 2000; UNEP, 2002). It has more than seven times more forest cover than the European Union and almost double the combined forest area of Canada and the United States while containing the greatest area of natural forest (UNECE statistical yearbook, 2003).

There has been a decrease in other wooded land (OWL – woodlands not dense or contiguous enough to be classified as forest of approximately 0.2% p.a. in Europe, similar to that of North America (TBFRA, 2000). Europe (not including the Russian Federation) now has forest cover of around 35% (FAO statistics), similar to that of the US, after having reached a low of 25% during the 19th Century. Since the 1950s, there have been proportionately fewer fellings compared to the increasing forest growth and this has made it possible to supply more wood, while simultaneously increasing the growing stock.

Throughout NAE there been a steady increase in both deciduous and coniferous plantations since early in the 20th century. This is now accelerating as planting technologies have improved and more agricultural land has become available for conversion to forest (Figure 2-17) There is a distinct trend towards a greater proportion of coniferous wood (now 69% in W Europe, 66% in CIS) being planted. European plantations make up 17% of world plantations with the Russian Federation having the greatest area in Europe. (FAO, 2000; TBFRA-2000; UNECE/FAO, 2000)

Insert Figure 2-17. Changes in NAE forest area.

Overall European and Russian forests sequester around 540 million tonnes of carbon per year, some 14% of the world's total sequestration, with US and Canadian forests sequestering about 200 million tonnes of carbon per year (UNECE/FAO, 2000a) There has been an increasing trend for forests to be planted specifically for carbon sequestration, funded by schemes set up as a response to the Kyoto Protocol. (Bowyer and Ramsetstein, 2004; MA, 2005)

2.6.2 Forest ownership and control

Over the past twenty years there has been a strong trend away from public towards private ownership of forests in W and S Europe, but almost all forest land remains in state ownership in the CEE countries, although this is changing towards private ownership in former Soviet states now in the EU-25.

Fifty-seven percent of all US forest land is privately owned, but 94% of Canada's forests are publicly owned. Approximately 10% of US forestland is legally protected from commercial forestry, more than double that protected in 1953. Around 66% of US forest land is classed as timberland (forest capable of producing in excess of 20 cubic feet per acre per year and not legally protected). Since 1953 the area of timberland has had a net loss of one percent primarily because it has become legally protected. Seventy-one percent of US timberland is privately owned.

In general forest growth rates exceed exploitation levels throughout NAE. Net growth rates have not been increasing as rapidly as in the past, while harvest levels have remained relatively stable since 1986. Increased imports have addressed the additional resource demands. Since 1960 the US forest resources have continued to improve in condition and quality as measured by increased average size and volume of trees; however, if quality is measured as a function of optimum stand density, i.e., optimum number of trees per acres for stands of a given age, then the overall quality of many stands has deteriorated (Smith et al., 2002).

Canada is the largest exporter of forest products with total exports valuing $44.1 billion (Natural Resources Canada, Canadian Forest Service, 2000). In 2002, one in 17 jobs was directly or indirectly linked to forests.

Less than two-thirds of annual forest growth in Europe (excluding Russia) is harvested, so the volume of standing wood in forests is growing. In Russia only 14%of annual growth is currently being harvested, less than the proportion being harvested in the 1970s (TBFRA, 2000).

The past thirty years have seen an increase in forest accessibility through construction of new logging access roads into remote areas. Conservation protection legislation has also been applied to many inaccessible areas over the past thirty years. In W Europe over 85% of forest is now available for wood supply; in CEE, where more forest is protected, 64% is available for wood supply (TBFRA, 2000).

<u>Biodiversity</u>

In both North America and Europe there has been an overall decrease in forest biodiversity due to reductions in areas of natural forest, illegal felling, increases in monocultural plantations, increases in serious fires and hunting activity in some countries, adverse effects of air pollution and more urban access into forest areas. GEO3 (2000) reports that around 60% of Europe's forests are now degraded by the factors listed above. This degradation trend may be reversing in some more developed countries (UK, Germany, some CEE countries) with higher levels of legal protection than the rest of Europe (> 10% of area protected) and development of new plantations that alleviate pressure on natural forest. In the NAE region, Canada and CEE has the highest proportion of forest undisturbed by humans.

2.6.3 Forestry as an industry

Demand for forest products in NAE has dramatically increased since the World War II, especially for industrial wood, with consumption and production more than doubling between 1961 and 2004 (UNECE/FAO, 2003b). Demand and production of fuel wood has increased from 1990 and now exceeds 1960s levels, but is still only 20% of industrial wood production.

Because of this, the forestry industry has steadily grown over the past 50 years from a rural activity supplying urban areas with timber products to a major industry producing a wide range of added value products, especially wood-based boards where Europe is one of the world's major exporters. Not only has there been a significant rise in consumption of and demand for, wood-based products derived from Europe, but there has also been a significant increase in the import of timber, especially fashionable tropical hardwoods, from other parts of the world, especially from Canada, S. America and the Far East. This import market has had an increasing impact on the forests of other continents and is an important factor driving forest loss in those areas. (FAO, Europa, UNECE).

2.6.4 AKST in forestry

In W and S Europe the main focus of forestry science has changed recently from the traditional productivist paradigm towards a scientific approach to sustainable multifunctional use, including the conservation of species associated with forests and the impacts of climate change. This trend is also found in parts of North America. Since the classification of American forests into ecoregions in the 1970s and 80s (Bailey, 1980; Bockheim, 1984; McNab and Avers, 1994), there has been a change in forest management away from exploitation towards multifunctional sustainability (Johnson et al., 1999; Bosworth, 2004) focusing on four objectives; watershed health and restoration (USDA-USFS, 1999), sustainable forest management, public access and recreation. These topics form the framework for most forest research in NAE.

Since 1945 many new technologies have been increasingly applied to forest production, harvesting and processing. Increased pesticides use, especially on conifer plantation monocultures, has led to less insect and disease damage to forests. Drainage and ground preparation techniques have been adapted and scaled up from agriculture, resulting in conversion of more open uplands and wetlands to forest.

Even using native tree varieties and labor-intensive forestry systems, foresters in Europe and North America have significantly increased productivity and production per unit area by employing new technologies for ground preparation (better drainage, fertilization and tree protection using physical and chemical means), planting technology using mechanical planters, improved management of plantations, advanced rapid timber harvesting and extraction machinery and high throughput processing (for paper, timber and board production). New harvesting technologies have increased harvest rates and result in a higher proportion of felled wood being processed, with less waste For example, in Sweden the introduction of the chainsaw and mechanization of logging operations resulted in total forest work productivity increasing between 2.3 and 12.5 m^3 per man-day between 160 and 1990 (Axelsson, 1998). Between 1970 and 1990, the degree of mechanization in final fellings increased from 25% to 85% and in thinning from zero to 60% (Frej and Tosterud, 1989).

The NAE timber industry also makes better use of fiber by-products (for board manufacture, insulation materials and fuel) than before 1945, when many of these products were simply burnt in the open on site. Much of this development was initiated from the state forest services, both in terms of funding and technical expertise. State services continue to have a major input into technology development, especially in the CEE countries, but in W and S Europe, forest technologies are dominated by a viable industry that exports machinery and knowledge for timber production and processing worldwide. In common with other manufacturing industries, production of machinery used in forestry and wood processing is increasingly shifting to the Far East, a trend that is set to continue.

The negative impact has been that the larger scale mechanization has lead to a major decline in the number of forest workers. Another negative consequence is that in systems such as short rotation forestry, soil compaction can be an important issue when considering the mechanization. This can have a particular impact where the crop is harvested in the winter months on wet soils, as can be the case in soils of Northern Europe. In these regions the crops are frequently grown on soil that is saturated during the winter months and soil damage is more likely to be significant (Culshaw and Stokes, 1995).

Unlike in agriculture, crop varieties used in plantations for commercial forestry are largely derived from selected wild stocks of trees, but not necessarily grown in their native region. Some of these are taken from stands known to grow well in the prevailing conditions and to produce good quality timber. Domestication of trees is still at a very early stage largely because selective breeding is more difficult with plants that have long generation times and that only exhibit desirable traits close to maturity, typically after several decades. Biotechnology and genomic knowledge is beginning to open up the possibility of true domestication of trees, partly by producing varieties with shorter generation times, but mainly through increasing knowledge of the genes responsible for desirable traits.

2.6.5 Forest institutions

Forest management in the United States and Canada has changed dramatically since 1945. In the United States, the Forest Service was formally established in 1905, assisting private forest land owners with management. The limited applicability of European management models to the US context, especially in the area of forest fires, provided impetus for forestry research (Williams, 2000). The US and Canada collaborate over research on forest health, sustainability and soils (Lal et al., 1997; O'Neill et al., 2005; Powers et al., 2005)

Europe has a large number of institutions that underpin the development of forestry as an industry and a social resource (UNECE, 2001). There are at least 150 forest research organizations and learned societies in Europe ranging from industry-sponsored research facilities, to academic departments (and entire 'Forestry Universities' in the CEE countries) and state-funded research institutions. These include at least 30 State Forest Services in Europe, some of them also responsible for wider land use issues such as agriculture, biodiversity conservation and water resources. They are often powerful and influential organizations, with substantial funding, human and capital resources. Besides the training available through the organizations above, forestry is included in the general higher educational curriculum of many NAE countries and there are dedicated training establishments for forestry and wood-based processing.

Throughout NAE forestry NGOs promote sustainable use of forests and campaign for better protection of natural forests. They include forest product consumers who question the ways in which their countries' forests are being managed and exploited. Consumer organizations are increasingly involved in lobbying for more sustainable forestry, both within and outside NAE. This has led to the establishment and expansion of certification schemes throughout NAE, which although controversial (ref), are aimed at assuring consumers that the forests from which their products are derived from forests managed according to a published set of management rules and objectives.

Although many NAE forestry societies, state forest services and research organizations were established over 100 years ago, these institutions have developed rapidly over the past 50 years, largely driven by the post-war need to increase timber and paper supplies to an expanding and increasingly wealthy public. They hold considerable political power and continue to be a key influence on the success of the forestry industry (World Bank, 2005).

2.6.6 Drivers of changes in forestry

Markets have always played an important part in forestry production, driven by demand for structural timber for rebuilding NAE infrastructure needed after World War II, meeting demand for increased timber and paper pulp due to an increasing population and demand for fuel wood that is now increasing after a decline from 1950 to 1980. There has been a steady increase in global demand for wood-based boards used in construction and fitments and this is expected to continue in the 21st century (ref).

State ownership and subsidies have also played an important role in the development of NAE forestry science and technology, especially the increased use of modern soil preparation, planting and harvesting technologies and processing equipment, has enabled the increases in forest output seen in the past fifty years. Rules and regulations have become increasingly important as drivers of forest management and protection, especially enabled by conservation legislation driven by EU Directives and North American statutes.

In NA, the main drivers of change in forestry have been the decreased demand for conversion of forestland to agriculture; increased demand and market pressures in North America and globally for wood and wood products; increased emphasis on non-timber products of forests, e.g., wildlife, range, water, outdoor recreation; and the increased recognition of the role of forests in climate change and protecting biodiversity.

<u>European Forests and Livelihoods</u>

Within the EU-15 area, some 2.7 million people are employed in forestry and forest-based industries such as woodworking, the cork industry, pulp and paper manufacture and board production. The industry produces an annual value of at least EUR 335 billion (UNECE/FAO; 2003a; EU EUROPA website). The EU is one of the world’s largest traders and consumers of forest products, with a net income in this sector. The EU also imports large quantities of forest products, primarily roundwood from the Russian Federation and wood pulp from the Americas, where higher growth and lower production costs make forest products from this region very competitive. The EU excels in the production of high value wood products such as boards, cork and specialist papers and is a key exporter in this sector. (Bowyer and Rametsteiner, 2004; EU EUROPA website).

At least 12 million people own forest holdings within the EU-15, mostly small scale owners with an average holding of 13ha, with most owning around 3ha, contrasting with the average area of 1,000ha for public holdings. Private owners occupy around 65% of Europe's forested land. Since enlargement of the EU large areas of previously state-owned forest holdings have been restored to private ownership. There is an increasing trend for private owners to supplement their incomes from urban-based incomes, with less dependence on income from forestry. (EU EUROPA website)

European forests are also economically and socially important because, besides providing the wood for industry, they also provide services such as leisure use (tourism, general recreation and hunting) and provide casual income for rural people from collecting valuable products such as fungi, berries and nuts. In Europe forests give many communities and individuals a strong sense of identity that is deeply ingrained in culture and societal values in many parts of Europe (e.g. rights to fuelwood, hunting and the collection of forest foods).

2.6.7 Trends in NAE forestry

NAE is the only world region where forest cover is increasing. Throughout NAE there been a steady increase in both deciduous and coniferous plantations since early in the 20th century. Timber productivity has increased since 1945 to meet increased demand, but NAE continues to import large quantities of wood, including hardwoods from tropical forests. This has been partly responsible for reductions in cover and quality of forests in other world regions.

Since 1945 there has been a shift from private to state forest ownership in the US. This trend was also apparent in Europe, but here ownership is increasingly being privatized. Forestry research and development has increased significantly since 1945. Technologies, especially mechanization, have been developed to achieve faster and more efficient harvests and to access and harvest timber in areas previously considered too fragile for harvest

Across NAE, there has been an overall decrease in forest biodiversity. However, adoption of ecosystem-based approaches to manage national forests and grassland has changed the way public/federal land managers in the US and Canada administer natural resources. Forest management for multifunctionality is an increasing trend in Europe, with the exception of Russia where productivity is still the key driver of management.

Forestry management continues to provide livelihoods and a cultural focus for large numbers of people in NAE and the forestry product industry has grown rapidly to accommodate increased demand for timber and other forestry-derived products.

2.7 Changes in Aquaculture Production

2.7.1 North American aquaculture

It is useful to divide aquaculture into two distinct types, freshwater and salt water (Figures 2-18, 2-19, 2-20 and 2-21). As a whole, Canadian aquaculture between 1986 and 2004 has grown at an annual rate of 20%.

Insert Figure 2-18. Production of major aquaculture species in the US (Note different scale for catfish).

Insert Figure 2-19. Production of major salt water aquaculture species in the US

Insert Figure 2-20 Canadian saltwater finfish aquaculture production. (Also see note in Figure [Hinga3]); Source Fisheries and Oceans Canada, Statistical Services 1986 to 200?]

Insert FIGURE 2-21. Canadian shellfish aquaculture (Source Fisheries and Oceans Canada, Statistical Services 1986 to 2004)

In the US modest amounts of fresh water aquaculture, dominated by catfish culture, have been practiced since at least the 1940s. In 2003, there were some 300 tonnes of catfish grown, representing 71% of all US aquaculture, fresh and salt water by weight; trout, talipia, crawfish and baitfish comprised the remainder (NMFS, 2005). Canadian freshwater aquaculture consists primarily of the rainbow trout and secondarily brook trout.

In Canada, the major aquaculture crop is salmon. The majority of the cultured salmon, 55 to 60%, is exported to the United States, with the other two largest export markets, Japan and Taiwan, each representing less than 2% of production. Steelhead trout is the other seawater finfish aquaculture, but is produced in much lower amounts (Figure 2-20). Through the late 1980s and 1900s there was a rapid expansion of clam and especially mussel aquaculture such that mussel is now the major shellfish aquaculture product by weight and by value (Figure 2-21).

By contrast, before the 1990's US salt water aquaculture was dominated by oyster culture. However, starting in the mid 1980s and continuing through the 1990s there has been a very large expansion of salmon aquaculture to become the dominant salt water product. Although, salmon is the currently largest salt-water aquaculture harvest by weight, the dollar value of oyster production ($63 million in 2003) is greater than that of salmon ($54 million).

Aquaculture products are growing in importance in both the US and Canada, although they are less than 15% of wild fishery landings. Aquaculture in 2003 represented about 10% of US wild fishery landings. The total Canadian commercial landings of wild fisheries in 2004 were 1,071,182 tonnes, while aquaculture production was 145,840 tonnes, or 13.6% of the wild harvest. However, for salmon in Canada the wild fishery landed just over 25% of aquaculture production in 2004. The US is a net importer of seafood primarily from Asia.

2.7.2 European aquaculture

The aquaculture sector in Europe has a very diverse production, processing and marketing structure, ranging from small traditional enterprises, through medium sized family fish farms, to the large-scale intensive businesses dominated by multinational companies (Fédération Européenne de Salmoniculture, 1990; MacAlister Elliott and Partners Ltd., 1999; Varadi et. al., 2001). Although there are structural differences between aquaculture sectors in different European regions, markets are now the determining factors of success and therefore the major driver in the aquaculture business with consumer demands, international competitiveness, health and environment issues and product quality all driving demand and price (Stirling Aquaculture 1996ab).

The total output from European aquaculture has increased steadily since 1945 (Tacon, 1997). From the 1960s to the present the broad pattern of aquaculture development has been (FAO, 1996, 2000; Eurostat website; Tacon and Barg, 1998):

- high growth in Northern Europe and medium growth in Western Europe fuelled by the development of salmonid mariculture;
- low growth in Southern Europe with a focus on mariculture of sea fish; and
- decline in Central-Eastern Europe due to general post-transition economic decline and changing consumer habits (Staykov, 1994; Szczerbowski, 1996).

Increases in the production of finfish and molluscs have almost always led to value reduction as the price falls. This has become a serious issue for the viability of salmonid farming in Northern and Western Europe, where ex-farm prices have dropped from 3.5 Euro/kg in 1997 to 2.4 Euro/kg in 2005. In Southern Europe the value of farmed sea fish has remained relatively steady. Overall production increases in European aquaculture have slightly outpaced falls in price, leading to an increase in total value from 3.4 M Euro in 1999 to 3.9 M Euro in 2005.

Subsidies from the EU have contributed to the development of the salmonid sector, but withdrawal of state support in Central and Eastern Europe may have contributed to the decline in cyprinid production. Other challenges for aquaculture include increasing concern from the public and from governments about the quality of fish produced in intensive systems and about the environmental impacts of fish farming and the competition for resources such as high quality water, high protein feed based on fish meal and labor.

Freshwater production has grown since 1945, but remained almost static in the 1980s, largely because output from the CIS countries and Russia declined (FAO, 1996). Increased fish consumption is expected, especially in Central-Eastern Europe, where per capita fish consumption still remains far below that of the EU-15 (Tacon, 1997). Overall production from freshwater aquaculture is now increasing, albeit at a much slower rate than production from saltwater (FAO, 1996).

Aquaculture in saltwater has seen a spectacular rise in output since the mid 1970s, when farming salmon in sea cages began to develop in Norway, Scotland and Ireland. Salmonid finfish production now dominates the saltwater sector, overtaking mollusc production in 1995. The success of increasing output from the salmon industry has been tempered by a collapse in prices in the early 1990s, in turn leading to government intervention such as the destruction of smolts and feed quota systems introduced in Norway in the mid 1990s (Anon., 1996). Besides salmonid production, other higher value species of saltwater finfish such as bass, turbot, sea bream, cod and halibut are now being intensively farmed in European seas, lagoons and purpose built tanks in coastal waters of the warmer southern European countries such as Greece, Italy and Spain (Tacon, 1997). The industry is still developing from a low base in the 1980s but production has risen rapidly, with for example sea bream and bass production growing annually by over 40% (315 tonnes to 17,000 tonnes) from 1984 to 1995 (FAO, 2000; FAO FISHPLUS website; Eurostat). Production rose to 120,000 tonnes in 2001, most of which was exported from Greece to Italy and Spain, but the market for these fish has now expanded to other European countries.

The main finfish species groups cultivated in the region are salmon and rainbow trout, with about 85% of total farmed finfish production (Eurostat and FAO). Salmonids freshwater cyprinids (mostly carp and eels) constitute the second major finfish species group cultivated in the region at around 12% of total farmed finfish production (Voronin and Gavrilov, 1990; Dushkina, 1994; Zaitsev, 1996). Production of mussels and oysters and other molluscs is still a major part of total aquaculture output in Europe. There has been a slow decline in output of molluscs since the mid 1980s driven by a combination of disease problems (Figueras et.al., 1996), changing consumer habits and competition from other aquaculture sectors. Europe is the leading world producer of farmed turbot (100%), eels (99%), mussels (70%), sea bass and bream (68%), salmon (60%) and trout (54%).

From a low base at the end of World War II, European mollusc production increased rapidly until the 1970s and then output has remained relatively static, with some evidence for a decline of about 4% in the past twenty years. Blue Mussel production in France illustrates this trend with output at 8,500 tonnes in 1950 rising to 47,000 tonnes in 1977, a level that is the average maintained since then (FAO FISHPLUS website). Mussels remain the dominant species in this sector (60% of total output), with oysters making up around 25% output and several species of clams the rest. The main mollusc production regions are in France (35% of total), Italy (26%), Spain (17%) and the Netherlands (13%). Mollusc production makes up around 25% of the total monetary value of aquaculture in Europe (Tacon, 1997; FAO, 2000).

Institutions in aquaculture production in Europe

National organizations representing the aquaculture industry have grown rapidly since the 1960s in the Northwestern European countries, handling policy, advice, marketing and research. Some of these, like the Fiskeoppdretternes Salgslag in Norway are effectively production and marketing monopolies, but most others are NGOs independent of the industry. For producers there is a European wide organization, the Federation of European Aquaculture Producers (FEAP), representing all national associations at EU level. In most Eastern European countries, aquaculture is usually organized and advised by the Ministries of Agriculture and Food, with the exception of the USSR where it is in a separate Ministry of Fisheries. This state intervention is rapidly changing as private companies are beginning to gain market share within the Central and Eastern parts of EU-25.

Public investment in fish farming has been and remains a major factor in the development of European aquaculture. In Central and Eastern Europe, public funding has come via state intervention, whereas in other parts of Europe, state and EU subsidies and development programs have played a significant role in developing both the fresh and saltwater aquaculture industries. Thus, although policy has historically been a driver of aquaculture development, state intervention is declining and markets are becoming more important drivers.

Fish farming is now strictly regulated in Europe with a number of Directives and domestic legislation covering water use and pollution control, the use of disease control measure (including pesticides) and feed regulations. There are also rules and regulations relating to the processing and marketing of aquaculture products. There is a trend towards stricter regulation and monitoring that adversely affects small family-owned enterprises (Varadi et al., 2001).

2.7.3 Science and technology in aquaculture

Since 1945 major breakthroughs have been made in fish farming techniques, including:

- The intensive hatching and rearing of sea fish in the southern countries
- Control of density dependent fungal and bacterial diseases in finfish
- Techniques for rearing salmonids in salt water
- The development of fish food processing and supply, including better formulation, the development of specialized feed and automatic feeding

These developments have enabled the spectacular increases in production seen in Europe over the past thirty years, especially in farmed salmonid and sea fish output (FAO, 2000). Most of this research and development has focused on high value finfish production, with far less work being done on mollusc and carp production, where production is mostly from units using traditional methods developed over centuries.

However, now research in aquaculture has changed to helping production systems address environmental issues including:

- Pollution of the sea caused intensive cage systems in coastal waters
- Pollution of rivers and streams caused by trout farming units
- Pesticide residues in fish flesh and the impacts of pesticide use in the marine and freshwater environment
- The impact on marine ecosystems of large-scale supply of sea fish for aquaculture feed, for example the 1990s near-collapse of food webs dependent on sandeels in parts of the Northwest Atlantic.

2.7.4 Key changes in aquaculture

Aquaculture, while practiced for centuries across NAE, has grown in importance since the 1940s, in most parts of the region except for Central and Eastern Europe. In Canada, for example, the industry is growing at 20% per year. There have been very large increases in aquaculture – both freshwater and saltwater – across NAE, propelled in part by explosive growth in salmon production. Despite this growth, North American aquaculture represents 15% or less of wild fishery landings by weight.

In the US, salmon has overtaken oysters as the major saltwater aquaculture and is the most important aquaculture crop in Canada. Salmon production is very important in Northern Europe, fuelled by good prices in the 1970s and 1980s. However, by the late 1990s, prices had dropped precipitously.

Due to developments in AKST, intensive rearing methods came to dominate aquaculture production. These production systems required the development of specialized feeds and control of fungal and bacterial diseases. Increases in salmon production were possible because of new techniques for saltwater production. However, the environmental impacts of these intensive production systems has caused aquaculture research to shift to addressing pollution concerns, pesticide residues and impacts on ecosystems.

2.8 Key Changes in Post-Harvest and Consumption Systems

Postwar consumer desire for adequate and safe food at modest prices has driven some of the changes described in the last few subchapters. We now turn our attention to changes in the consumption systems that exist across NAE. In line with trends across the OECD, the share of overall consumer spending on essentials (food, clothing, energy) has declined in Europe; in the UK, it has halved in 40 years. In the UK, one pound in three spent on food is spent away from home and in Ireland it is estimated that one Euro in every four is spent away from home (Henchion and McIntyre, 2004). Declining relative expenditure on food and even food price deflation is a major factor in the level of competition in food retail.

2.8.1 Changes in the food retail sector in NAE

Food retailing has experienced significant changes since 1945. Today, the giants of European food retail are Germany, France and the UK, based on their high populations and mature markets. The ownership structure of the largest companies in European food retail is varied. Carrefour (the world's second largest retailer) and Tesco are publicly held. Metro is publicly held, but with a large proportion owned by founder Otto Beisheim, the Haniel group and the Schmidt-Ruthebeck family. Rewe is a cooperative owned by its 3000 retail members, while ITM Intermarché is a consortium of independent merchants. Food accounts for around three-quarters of sales for these companies, except Metro where the figure is closer to 50%.

In 2003, European food retailers accounted for 46% of all European retail sales. The food retail market in Europe is very mature, but the food retail sector has increased its share of the wider retail market in all but four of 19 countries (France, Spain, Sweden and Denmark) by 19% to €870bn between 1999 and 2003. Tesco's sales rose by 54% and Wal-Mart Europe by 32% thanks entirely to the Asda operation in the UK. Non-food is the driver of this supermarket growth, since food sales are relatively stagnant.

There is a close relationship between per capita GDP and the penetration of 'modern' retail (Figure 2-22). But what is interesting from a European perspective are the outriders, such as Italy with about 20% below that predicted and the UK, which is about 15% above that predicted by this relationship. Whether this phenomenon points to durable exceptions to the rule based on cultural or policy differences, or simply to time lags in some countries, is not currently clear.

Insert Figure 2-22. Large supermarket penetration vs GDP per capita

In CEE countries, the penetration of large supermarket chains in the national food retail markets is quickly approaching saturation. The EU average is 15 hypermarkets per one million inhabitants. Hungary has 10 million inhabitants and by the end of 2005 there will be 98 hypermarkets in the country. Hypermarkets in Hungary now account for around a quarter of the market. Modern retailing already has an 18% share of the Russian market. This trend towards supermarket penetration in food retail has decreased the number of farmers' markets in many CEE countries.

While there is a general trend toward concentration in Europe, Dobson et al. (2001) point out that the emerging structures of food retail are not always the same These authors use a typology of the *dominant firm* (when the market share of the top firm is >25% and at least twice as high as the second rated firm), the *duopoly*, the *asymmetric oligopoly*, the *symmetric oligopoly* and *unconcentrated* structure (when no firm has a market share >10%) (Table 2-8). In 1999 Italy was the only country ranked as 'unconcentrated', though this no longer applies now that Coop Italia has a 12.5% share.

Insert Table 2-8. Market structure of retail in Western Europe, based on market shares of top 5 retailers

The internationalization of retail in Europe has been, by comparison with other sectors, a recent phenomenon. There is still quite a strong national characteristic to food retailing in many Western European countries (Table 2-9) though this (a) hides high levels of international collaboration between firms in pan-European sourcing to increase buying power, with buying groups especially strong in Scandinavia and (b) the rise of the deep discounters such as Aldi up the ranks of national players. Food retail in most CEE countries is dominated by the multinational chains. The top 10 retailers in the Czech Republic, for example, are all multinationals. Nevertheless, some domestic cooperatives, trade associations and retail chains (such as COOP, CBA and Reál in Hungary, or VP Market in the Baltic countries) have been able to hold their own against competition by international retailers (Juska, 2002).

Internationalization allows retailers to use their distribution systems for pan-European procurement. Tesco, for instance, exports Hungarian products under its private labels; the firm announced last year it aimed to export HUF 1 billion in Hungarian goods in 2005, with increases of Hungarian goods to the Czech Republic, Slovakia and Poland. French-owned hypermarket Auchan also said recently it will increase the sale of Hungarian products outside Hungary's borders to HUF 5 billion in several years' time.

Insert Table 2-9. Top retailers across Europe—summary.

Own brand (private labels) are still rising in the European supermarket scene with an average 26% market share in Western Europe (Table 2-10). Growth is strong in parts of CEE—the share of private label products in Hungary was 15% in 2003 and own-brand goods account for around 25% of the total Tesco revenue in Hungary. The tight price squeeze forced by supermarkets has been responsible for own brand manufacturers such as Northern Foods struggling with profitability.

Insert Table 2-10. Outlook for private label in Europe (% sales)

'Trade spend' is another important feature of European retail, also known as *marges arrières* (back margins). Supermarkets have been able to use their gatekeeper position to make money on the buy side. This 'trade spend' for suppliers to secure business with supermarkets comprises reimbursements to the retailer for the range of products it carries and promotions it carries out and includes supplier rebates, overriders (a discount or rebate related to the performance of the customer, paid in retrospective), unilateral deductions from money due or even demands for ad hoc cash payments. "A typical big European retailer might extract the equivalent of 10% of its total revenues via trade spending" (Economist, 2006).

Discounters are a growing part of the European food retail landscape with some notable exceptions such as the UK and Ireland. Discounters are a huge part of the market in Germany—in 2003, Germany accounted for 43% of Western Europe's 32,500 discount stores. But deep discounting is also growing fast in France, where there is a growing emphasis on price.

Buying groups or **'**international purchasing and marketing organizations' are means by which supermarket companies and consortia can increase their buyer power especially when negotiating with the big brand manufacturers. This is demonstrated by the GNX platform offering for auction contracts worth $8bn. Associations between buying groups and the top 30 retailers in Europe are common. The largest, EMD, has a 10.6% market share in Europe and a sales volume of EUR 950 million. Buying groups can have a significant impact on actual industry concentration. For instance in Hungary, from the Top-10 list SPAR and Metro form the buyer group METSPA with more than USD 1,800 million sales and Cora (Delhaize group) and Csemege are part of the PROVERA buyer group. Because of the buying groups, Grievink (2003) estimates that in western Europe, only around 110 buying desks account for about 85% of the total retail food (not foodservice) sales of the western European countries (see Figure 2-23).

Insert Figure 2-23. The supply chain funnel in Europe

Consolidation of retailers' supply base is creating conditions in which competition between suppliers creates its own pressure on producer prices. For example, between May and August 2004, the big three UK supermarket companies all announced rationalization of their milk supply, to two suppliers in the cases of Tesco and Sainsbury's and one in the case of Asda.

2.8.2 Concentration and trends at national levels

Germany is famously the toughest market in Europe. Deep discounters have a huge share of the market, accounting for 27% of modern grocery distribution sales, with that share around 50% for some product areas such as milk. The position of discounters is supported by strict planning laws for 'big box' retailing, consumer perceptions of discounter private labels as good quality and popularity across income groups. The rate of growth of the UK food market has slowed and competition at the consumer side is very intense, with a permanent price war. Many firms have struggled to remain competitive and build critical mass in a market where market share is perceived to be key to success, including Morrison's (following the acquisition of Safeway), Marks and Spencer, Sainsbury's (only just starting to reverse a decline) and even Asda (part of Wal-Mart group) which has recently reported disappointing figures. This turmoil is not limited to publicly owned companies. The Cooperative Group is now searching for 'efficiencies' after poor sales figures following a series of acquisitions. Only Tesco seems to have managed consistently strong growth in market share at home and abroad (half of that shelf space is now overseas), profits and shareholder value in this period of consolidation of the UK retail sector, while taking massive chunks of business from clothing, electronics, financial service and other non-food sectors. The craft retailer Waitrose has also prospered.

Primary producers and suppliers are feeling the squeeze on prices. In a recent survey of farmers by Farmers Weekly magazine, a massive 95% of those questioned were concerned about power imbalance between buyers and suppliers, saying that the government must find ways to make trading relationships between retailers, processors and producers more equitable. Caribbean banana producers have called the price war "perverse transfer of wealth, by some of the supermarkets, from farmers and farm workers of developing countries to the consumers of developed countries" and "anti-development and regressive" (Eurofruit, 2004).

Despite investigations by the Competition Commission in 2000 and again in 2003 (around the Safeway takeover by Morrison's) and the resulting Supermarkets Code of Practice and subsequent review by the Office of Fair Trading, it is clear that consumer interests remain dominant over those of suppliers in the eyes of the Office of Fair Trading. Indeed, the situation in the UK around producer-supermarket trading can only be described as policy paralysis.

The UK independent retail sector is in steep decline, with a 7.4% decline in the number of corner shops in the last year alone. Industry watchers say 30,000 local shops - including specialists such as butchers, bakers and greengrocers - will be lost in a decade.

In North America, food retailing had a relatively slow pace of consolidation. A major wave of consolidation happened in the late 1990s, when Albertson's Kroger became the first coast-to-coast supermarket chains. By 2001, Kroger and Albertson's were the largest US grocers. However, Wal-Mart, which until the early 1990s had never sold any groceries, became the largest grocery retailer in 2004, with about 15% of the US grocery market. In Canada, Loblaw's is the dominant grocer in the Canadian market, with Sobey's competing for the number two position.

Insert Table 2-11. Food retailing in USA

Today, the top five supermarket chains (Wal-Mart, Kroger, SuperValu, Safeway and Ahold) account for almost 50% of food retail sales in the United States (Table 2-11). By comparison, the top five food retailers accounted for only 20% of food sales in 1993.

When Wal-Mart entered the supermarket business in the mid-1990s, other stores were wary because of the incredible logistics system and supplier pricing that Wal-Mart brought to the business. More importantly, Wal-Mart's large size and market power caused concern as it integrated backward in the food system by creating relationships with the dominant food chain clusters. Wal-Mart is one of the first supermarkets to use case-ready meat in its stores.

The end of the 20th century saw the emergence of truly global food retailers like Carrefour, Wal-Mart and Tesco. Considering the rapid consolidation of the Latin American supermarket industry by transnational firms, development policy will need to respond to the resulting exclusion of small farmers from regional agrifood markets (Reardon and Berdegué, 2002).

The significance of the changes in food retailing for production is in the restructuring of supply and distribution networks and in the development of standards enforced by retailers (Reardon and Berdegué, 2002). While food manufacturers have sometimes embraced consolidation because it decreases transaction costs, it also distorts power in the chain and puts the food retailers in a more powerful position (Stanton, 1999). Another result of restructuring is increasing retailer fees, some of which cover real costs but which are also used to generate an income stream that creates more gross profit for retailers (FTC, 2000). Manufacturers attributed the rising use of fees to greater retailer influence, while retailers attributed it to the increased cost of handling products (FTC, 2000).

In this arena of negotiated power between manufacturers and retailers, US retailers seem to have an edge, with bigger chains charging higher retailer fees (FTC, 2000). As power shifts to the largest retailers, evidence from the UK indicates that profitability does also (Wrigley, 1997). However, retailers are at the mercy of those manufacturers who have successful brands because branding is one way to create leverage with retailers. Retailers begin to develop one-on-one relationships with dominant food manufacturers who can service their far-flung systems. Moreover, retailers can start dictating terms to food manufacturers from their position of power at the point of consumption (Mehegan, 1999). Increasing consolidation of the retail sector has essentially constrained the way that farmers can respond to the changing nature of the global food system (Burch and Goss, 1999).

The point is that there exist dynamic social relationships within the channel from production to consumption although the trend seems to be that it is more and more difficult for smaller entities in any one sector of the chain to compete effectively. The development of these anti-competitive practices in supply chain management concerns many observers, including those from business schools (Hildred and Pinto, 2002).

2.8.3 Changes in food manufacturing and processing

The major food manufacturing countries in Western Europe are France, Germany the UK and Italy. Meat, beverages and dairy are the biggest sectors, comprising 20, 15 and 15% respectively of the value of production in 2001 totaling over EUR 600 billion (USDA-FAS, 2003). It is Europe's leading industrial sector and third-largest industrial employer (Table 2-12). Concentration in the food manufacturing sector is relatively low.

Insert Table 2-12. Top European food manufacturers, ranked by turnover in 2002]

2.8.4 Market segmentation

One of the main changes occurring in the last 50 years in NAE can be describe as a growing segmentation of the food markets and the emergence of food niche markets, such as PDO/PGI and TSG products in Europe and organic and fair trade production both in Europe and in North America. The process of market segmentation has been facilitated by the development of an increasing number of food standards and an articulated system of food labeling and certification.

Rise of uniform quality standards for food manufacturing/retailing

In recent years there has been a great increase of a all types of standards[2] in the agrifood system (e.g. food safety, food quality, environmental standards). The prominence of standards has started as regulation of agrifood systems has shifted from nation-states to a broader set of organizations and institutions of the agrifood systems which also include global governance organizations, (e.g., World Trade Organization), multilateral and regional regulatory schemes, (e.g., the EU) and private sector organizations, including transnational corporations (e.g., Cargill and Wal-Mart) (Scholte, 2000; McMichael, 2004; Higgins and Lawrence, 2005).

As the organization of agrifood systems has shifted, standards have become one of the most significant emerging practices for governing food (Bain et al., 2005; Higgins and Lawrence, 2005). Economists have typically highlighted the role standards play in helping to reduce transaction costs, increasing the predictability of a product and in general, simplifying what could be a very tedious and complicated process. With the increasing importance of standards, however, a shift has occurred from the use of standards as technical tools for market homogeneity to the use of standards as strategic tools for accessing markets, coordinating systems, enhancing quality and safety assurance, product branding and creating niche markets (Giovannucci and Reardon, 2000; Reardon et al., 2001).

The importance of standards has been recognized especially as the way in which the globalization of agriculture and food has been operationalized. Many authors have pointed to the growing concerns surrounding the distributional benefits of standards, especially for poor countries, small scale producers (both in poor and rich countries) and farmers utilizing alternative production systems (Dolan and Humphrey, 2000; Reardon and Farina, 2002; Dunn, 2003; Freidberg, 2004; Unnevehr and Roberts, 2004; Bain et al., 2005). In particular, this growing body of research has highlighted: the rise of different types of standards, the lack of opportunity for specific groups to participate in standard setting, the high costs associated with standards adoption and the elevation of standards that require adherence to specific forms of production and processing in agrifood systems.

[2] "Standards are documented criteria or specifications, used as rules, guidelines or definitions of characteristics, to ensure consistency and compatibility in materials, products and services. In use standards become measures by which products, processes and producers are judged" (Bain et *al*. 2005: 81). Standards for animal agriculture tend to focus either on food safety or product attributes, which generally encompass quality concerns like meat tenderness or animal welfare issues (Ransom 2006).

Historically, standards in most national food sectors have focused on what are called product (or performance) standards— that is the composition (e.g., shape, color, etc.) of the final product and/or health features of the product (e.g. pesticide residues, contaminants, etc.) all of which are easily measured in the end product (Hannin et al., 2006). In much of the recent standards literature the explanation for the emergence of food safety (or product) standards has to do with the decline of nation-state regulation combined with the many well-publicized food safety scares that have occurred in various countries (e.g., BSE - bovine spongiform encephalopathy, E-Coli contaminated meats and vegetables and dioxin-contaminated chicken). Thus, in order to reassure consumers of the safety of food products, countries and companies have imposed more stringent food safety standards. In Europe, NGOs pressure activities and consumers demand are often mentioned as the explanation for the increase in animal welfare standards and more broadly quality standards (Murdoch and Miele, 2004; Miele et al., 2005). Quality standards, (i.e., organics, fair trade, animal welfare) as opposed to food safety standards (i.e., pesticides residues, contaminants), are processed based standards, which means that the focus is on how the product is produced, with definitions of quality revolving around shared, socially constructed values (such as environmental conservation or regional characteristics) (Renard, 2005). Moreover, quality standards are voluntary standards and it is argued that industry leaders adopt voluntary quality standards due to consumer demand, or at the very least, to allow retailers to differentiate products along lines that appeal to consumers, such as animal welfare, environmental sustainability and worker welfare (Hatanaka, Bain and Busch, 2005).

2.8.5 Food safety, quality regulation and food market niches

Created by FAO and WHO, the Codex Alimentarius Commission has elaborated many international standards. According to the Codex Alimentarius definition, food safety is the assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (Codex Alimentarius, 1997).

Recent food scares in NAE have stimulated public concerns about food and farming. Consumers find it difficult to know where their food comes from, how it is produced and how far it has traveled. Food provision is increasingly organized through complex supply chains, often on a global scale. This has implications for consumer confidence, food safety and public health. In order to address this problem at the global level a number of international standards for food have been elaborated. For food safety the most widespread standard is HACCP which stands for "Hazard Analysis at Critical Control Point". The Codex Alimentarius Commission has adopted HACCP as the international standard for food safety. Under the EU food hygiene legislation, there are over a dozen measures covering specific products, an initiative to consolidate all hygiene legislation into one single text led to the implementation of EU Hygiene of Foodstuffs Regulations,

1998. While HACCP had its origin in the USA, it has now been introduced by the Hygiene Rules 93/43/EWG in the production line of food in Europe. It bears the main ideas from the worldwide-accepted HACCP-System of the FAO/WHO Codex Alimentarius (OURFOOD, 2005).

Chronology of HACCP development (OURFOOD, 2005):

1959 - Development of the HACCP concept to assure one hundred percent safety of food to be used in space.

1971 - The HACCP system was published and documented in the USA.

1985 - The National Academy of Science (NAS) recommended the use of the system. Worldwide the system became used and the FAO/WHO Codex Alimentarius (Food and Agriculture Organisation/World Health Organisation) cited the system in the Codex.

1993 - The European regulation 93/43 EG since 1993 provides the use of the system for the production of food.

The International Organization for Standardization (ISO) has developed the ISO-9001:2000 quality system that aims to enhance customer satisfaction. This includes the processes for continual improvement of the quality system and the assurance of conformity to the customer and applicable regulatory requirements. In global business the certification according ISO 9000 turned out to be an imperative duty. Cerrtification to an ISO 9000 standard does not guarantee the compliance (and therefore the quality) of end products and services; rather, it certifies that consistent business processes are being applied.[3] Although the standards originated in manufacturing, they are now employed across a wide range of other types of organizations, including colleges and universities. A "product", in ISO vocabulary, can mean a physical object, services, or software. ISO 9000 and ISO 14000 standards are implemented by 760,900 organizations in 154 countries (Tables 2-13) (ISO, 2005).

Insert Table 2-13. Top ten countries for ISO 14001 certificates

ISO 22000:2005 Food Safety Management Systems Standard is an international standard that defines the requirements of a food safety management system covering all organizations in the food chain from “farm to fork”, including catering and packaging companies. This standard has been developed to harmonize the growing number of national standards for food safety management. The standard combines generally recognized key elements to ensure food safety along the food chain including: interactive communication; system management; control of food

[3] Certification body is URS Certification Ltd in India and Europe which accredited by NABCB and UKAS (http://www.ursindia.com)

safety hazards through pre-requisite programs and HACCP plans; and continual improvement and updating of the management system.

Niche markets. Product differentiation has provided special niches in food markets. These markets have been developed by granting protected trade marks/ names so that consumers can easily distinguish the special flavor or quality of niche products among similar commodities. These schemes are increasing important for rural development across Europe. Their implementation in the US is a relatively new phenomenon with such regions now being delineated ecologically rather than politically, culturally or economically (Barham, 2005).

<u>The market for organic products</u>

In 2004, the market value of organic products worldwide reached 23.5 billion EUR (27.8 billion USD), with a market growth of about 9%. The leading regions were Europe, with a share of 49% and North America with a share of 47%. The three largest country markets were USA ($12.2 billion); Germany ($4.2 billion) and the UK ($1.9 billion) (Willer and Yussefi, 2006). In 2005, the global market for organic products reached a value of 25.5 billion Euros, with the vast majority of products being consumed in North America and Europe. For 2006, the value of global markets is estimated to be at more than 30 billion Euros.

The distribution of the European organic market continues to broaden and deepen as more consumers are attracted in more sectors and in more countries. In Germany a growing number of conventional supermarkets are offering organic products and the number of organic supermarkets continues to increase with 40 new organic supermarkets opening in 2004 alone. The UK market continues to show healthy growth, with much of the growth occurring in non-supermarket channels like organic food shops, box schemes and farmers markets. A growing number of catering and food service companies are also offering organic food. The Italian and French markets are the next most important in Europe, however growth rates have slowed in these countries. A smaller market for organic food is found in CEE countries with the region comprising less than 3% of European revenues. Demand for organic products is growing through all CEE countries including Russia, particularly in metropolitan areas.

The data for the European market is fragmented and reliable detailed country comparisons are difficult to make because of the differences in data collection methods. However, FiBL have estimated the data which contribute to the profile of the European market reflected in the following tables for 2003 in which year the European market for organic food and beverages amounted to € 11 billion (Table 2-14).

Insert Table 2-14. EU market countries clustered by stage of organic market development, 2001

The North American market for organic products has reported the highest growth worldwide. Organic food and drink sales in the US were estimated to have totaled approximately 14.5 billion USD in 2005. With healthy growth rates continuing, the region is expected to overtake Europe and represent most global revenues in 2006. The driver for growth is the increase in marketing and distribution channels, with traditional, dedicated organic retailers like Whole Food Market and Wild Oats being joined by mainstream food multiples. Mainstream grocery retailers now comprise most organic food sales and the range of products is expanding in supermarkets such as Safeway, Albertson's, Wal-Mart and Kroger. The Canadian market is also reporting high market growth.

Demand in North America has become so high that local producers are having difficulty in matching supply and organic products are being imported from across the world e.g. organic seeds and grains are coming in from Europe and Asia; organic herbs and spices from Latin America and Asia; organic beef is imported from Australia and Latin America. Large food companies dominate almost every sector with companies such as Dean Food and General Mills active in the market. North America has organic food companies such as Hain Celestial, Sun Opta, Whole Food Market and Planet Organic listed on the stock exchange (FiBl, 2006)

Fair trade

In 2003, the global Fair Trade sales were over $895m and sales could increase by a factor of 20 or more in the next few years (Nicholls and Opal, 2004). Half the UK population is now aware of Fair Trade and there are similar figures for other European countries. Sales of fair trade products in Europe are growing remarkably well in several countries, largely stagnant in other countries and are not prominent in CEE countries. In 2004 sales grew of 102% in France, 50% in Belgium and 60% in Italy (Wills, 2005) (Table 2-15).

Insert Table 2-15. Fair trade in Europe – data 2003-2004

The findings of the 2005 Fair Trade Trends Report (The Fair Trade Foundation, 2005) clearly demonstrate that the Fair Trade movement has continued to grow rapidly over the past five years. In 2003, total Fair Trade sales in North America including Mexico reached $291.75 million, a 53% increase over 2002. The US Fair Trade sales currently represent a potentially huge market for the initiative. US Fair Trade market is the largest single national market in the world after UK and the sales are increasing remarkably (Table 2-16).

Insert Table 2-16. Total gross sales in North America (US and Mexico) 2001- 2003

Fair Trade Coffee. In 2002, FLO estimated the income benefit to Fairtrade producers at £21m, of which £17m was attributable to sales of Fairtrade certified coffee. TransFair USA estimated that, in five years of activity in the USA, Fair Trade has returned over £16.8m to coffee farmers in developing countries above what they would have received in the conventional market (TransFair USA, 2004). Fair Trade coffee sales vary considerably among different European countries. While coffee sales keep increasing in some countries, in general in Europe are largely stagnant.

By contrast, in North America, strong national campaigns have allowed a significant growth and it is likely that in the US and Canada, fair trade coffee sales will reach a market ceiling similar to that in Europe (Murray et al., 2003). Fair Trade Certified coffee is now the fastest-growing segment of the US specialty coffee market. The retail value of TransFair USA certified coffee increased by 59% in 2003 for a total of $208 million and by 77% in 2004 for a total of $369 million.

Fair Trade bananas

Fair Trade bananas were introduced in Europe by Max Havelaar in 1996. Since then, Fair Trade bananas had grown 14,655 tonnes by 1998 (data FLO in Murray and Raynolds, 2000). They have captured unprecedented market shares; sales have risen by over 25% per year since 1999, reaching a market share of over 45% in Switzerland (FINE, 2006).

Alternatively traded bananas have emerged in US in different way compared to Europe. In US the NGO Rainforest Alliance has certified bananas under its ECO-OK and 'Better bananas' program in 1999. Instead of building an alternative trade that challenges the power of bananas multinational corporations, this NGO has fostered a close collaboration with those companies (Murray and Raynolds, 2000). Trainsfair USA began certifying Fair trade bananas only in January 2004, data of market shares for FT labeled bananas are not available.

2.8.6 Changes in diet/consumption

The general context in NAE is that of a contrasted situation between the food shortage post WWII, especially in Europe and the present situation of affluence and surplus in North America and Europe. This trend is attested by a number of key indicators of food provision (c.f. Chapter 8 in Millennium Ecosystem Assessment, based on FAOSTAT 2004 data). The average food production per capita in the world increased from 1961 to 2003 by around 25%. There were huge inequities between industrial and developing countries. This was accompanied by falling food prices, as there was a strong decline in the relative importance of food within total consumption expenditure from above 40% after WWII to 12-20% in Europe in 1999, (EUROSTAT, 2001) and to 10% in the United States in 1996 (USDA, 2006).

According to 2001 estimates, 13% of the household budget in the EU15 was spent on food and non-alcoholic beverages, but the share of the budget spent on food fell between 1995 and 2001, mainly as a result of increasing available household income. Logically, the share varies with GDP per head: the lower GDP per head of a country, the higher the share of money spent on food.

In 2005, the consumption of food and drink represented on average 16% of total consumption expenditure per person in the EU-15 countries and 27% in the new Member States (EEA, 2005). Food and drink used to account for the largest share of household consumption, before being gradually overtaken by other necessities such as housing, transport and leisure (Table 2-17). Consumer patterns across the enlarged EU reflect income differences but also the availability of goods and services.

Insert Table 2-17. Household consumption expenditure in the EU-25 in 2003 (%)

Significant differences persist among member states (Tables 2-18 and 2-19). The lowest share of expenditure is found in the United Kingdom (9.7%) and the highest in Portugal (18.5%). The share of food and drinks in household expenses remains important in the new member states with an average of 22% against 12% in the EU 15 (Eurostat, 2005). Consumers' habits vary substantially among the 25 Member States. In addition to income, factors such as culture, tradition, household composition and degree of urbanization can influence habits in each country. The accession of the 10 new Member States has made the differences even more apparent than before (USDA, 2005). The share of citizens' total expenditure on food is projected to continue decreasing. Indeed, food consumption expenditure in the EU is projected to increase by 17% between 2000 and 2020, while in the same period total household expenditure could increase by 57% (EEA, 2005).

Insert Table 2-18. Proportions of expenditures in real values (average of 1995 and 1999)
Insert Table 2-19. Index of relative price (GDP index for each country, 100)

Changes in food provision and food nutrients. Increased food availability was made possible by increases in production and labor productivity in all sectors of the agricultural and food chains (see data in previous parts of chapter 2). AKST has played a major role in this phenomenon, as intensive livestock and crop systems were developed in order to meet quantitative food demand.

These changes in food provision resulted in increased amounts of food calories, as well as protein and fats available for consumption in Europe and North America (Tables 2-20).

Insert Table 2-20. NAE food supply: energy, protein and fats per capita per day

Available food calories have increased in the range of 18-26% in Western Europe and USA between 1961 and 2003, presently reaching values of 3500 to 3900 calories per capita per day. During the same period, protein supply has increased by 22-25% and fat supply by 29-41%. Increases were much more modest in Eastern Europe, as food calories increased by only 3% and protein by 4% between 1961 and 2003. In contrast, total fat supply increased considerably, i.e. by 37% in the same period.

Noteworthy is the amount of calories provided by lipids in the diet, which is presently around 40% in Western Europe and America, but 30% in Eastern Europe (derived from data presented in Table 2-20). Another feature is the change in the percentage of calories or nutrients derived from animal vs. plant products for Western and Eastern Europe (Table 2-21). Whereas the percentage of calories from animal origin slightly increased between 1961 and 2003, the percentage of proteins from animal origin increased more dramatically (reaching 60% in 2003 for Western Europe). In contrast, the percentage of animal fats in the diet actually decreased over the same period, especially in Eastern Europe where it was quite high in the 1960s.

Insert Table 2-21. NAE food supply: percentage of energy, protein and fats from animal vs. plant origin

2.8.7 Key Changes in consumption systems

Across NAE, the amount that consumers spend on food provisioning has significantly decreased, reflecting the decline in real prices for food. However, this change has been accompanied by an increasingly differentiated food marketplace. Consumers across NAE are spending more on food eaten away from home and strong markets for organic, fairly trade and other nice food products have developed in NA and Western Europe, with less interest in these markets in most CEE countries.

The food retail market has become increasingly consolidated across the entire region, resulting in a shift in power away from farmers to food retailers. The increase in standards, some resulting from concerns about food safety and others from demand for quality, has also created some market barriers for farmers. In addition, the widespread availability of so much food has affected diets and diet related diseases across the region.