

Chapter 5

CAPACITY BUILDING AND SERVICES FOR THE US FOOD AND AGRICULTURE SYSTEM

This chapter outlines the role of infrastructure capacity, skills and education in facilitating innovation in agri-food. It describes the governance of policies to improve rural infrastructure, outlines main regional programmes and reviews briefly the quality and coverage of rural services. It then discusses efforts to respond to skills demand from the agri-food sector through labour, immigration and education policy. It also reports on trends in education expenditure and outlines the performance of the education system. Finally, it provides an overview of education levels in agricultural and enrolment in agricultural programmes, outlining the gap between skills supply and demand in the sector.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Infrastructure and rural development policy

Investments in physical and knowledge infrastructure, from Information and Communications Technology (ICT) to transportation facilities, are important for overall growth and development. They are vital to the delivery of and access to important services and play a critical role in linking farmers and related businesses to markets, avoiding food waste, boosting agriculture productivity, raising profits, and encouraging investment in innovative techniques and products. Productive and profitable enterprises may have higher incentives to invest in sustainable practises that yield long term benefits.

Broader rural development measures also affect sustainable agricultural development and structural adjustment. Increased off-farm income and employment opportunities mitigate farm household income risks, facilitate farm investment, and enable a wider range of farm production choices. Improved rural services, from banking to ICT, are important to ensure needed connectivity to suppliers, customers, and collaborators. Rural policy can also attract innovative upstream and downstream industries, with possible spillover effects locally. By reducing inequalities in economic development and access to services across regions, rural development policies improve the diffusion of innovation.

US agriculture relies on an extensive physical infrastructure of transportation, communication, and electricity facilities, which have facilitated innovation in agriculture. Physical infrastructure relies on a mix of public and private ownership and financing, and federal, state, and local governments all play important roles in financing, regulating, and managing infrastructure.

US agricultural production is primarily carried out in rural areas. The US Government rural development programmes — primarily aimed at housing, economic development, health care, and infrastructure — therefore also affect agriculture, although the overlap between agriculture and rural America is far from exact. About 20% of nonmetropolitan counties, and less than 5% of metro counties, are also farming dependent counties, where agriculture accounts for at least 25% of the income generated in the county.

Physical infrastructure

According to the World Economic Forum’s Global Competitiveness Report, the United States ranked 16th among 144 countries surveyed and 13th among OECD countries in 2015 in the overall quality of its transport, communications, and energy infrastructure. The United States ranks above average among all OECD countries in terms of the quality of its roads, railroad infrastructure, port infrastructure, air transport infrastructure, and electricity supply, but below the top-five OECD countries¹ on most of these indicators except air transport for which it ranks third (Figure 5.1). The quality of transport infrastructure has deteriorated since the crisis with the marked slowdown in the growth of public investment (OECD, 2016).

State and local governments make most decisions regarding infrastructure provision, with coordination arising when projects require several governments to act together as in the case of transport infrastructure (OECD, 2016).

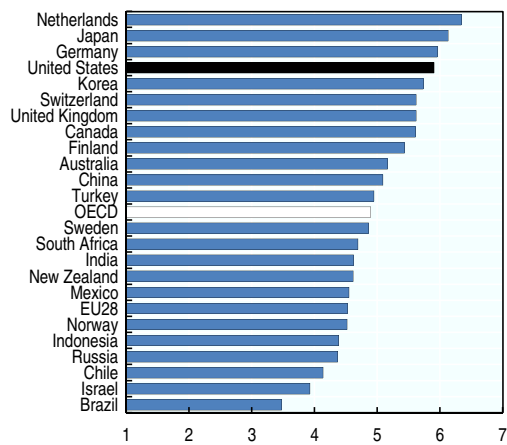
The United States ranks slightly higher than the OECD average in the quality of electricity supply as assessed by a panel of executive leaders, and the number of fixed broadband subscriptions and fixed telephone lines per capita. However, fixed broadband communication is generally at lower speed and higher costs. The United States is below the average for OECD countries in the number of mobile telephone subscriptions per capita (Figure 5.2). Mobile telephone subscriptions per capita are much higher in the top-five OECD countries, but also in many less-developed countries. However, the United States has led the world in high speed Long-Term Evolution (LTE) mobile telephony that now covers over 95% of the continental territory. While Internet development has been mainly privately funded, recent federal programmes aim to enhance household Internet participation. Potential for greater competition is emerging in the fixed-line broadband sector with new entrants to the market beginning to create or augment existing networks, and posing potential competition challenges. In addition, some States impose prohibitions on municipalities creating their own networks.

Access to infrastructure and urban centres varies greatly across the United States. For example, most of Alaska, much of the Mountain West and Great Plains regions, and substantial portions of the rural South, Central Appalachia, and Maine are at least a one-hour drive to the nearest urban centre of 50 000 or more (Figure 5.3). Access to all forms of infrastructure follows similar contours. For example, most of the eastern half of the country has access to fixed broadband connections, and virtually all of this region has access to wireless broadband (Figures 5.4 and 5.5). By contrast, most of Alaska and much of the rural West lack access to broadband service (especially fixed broadband).

Figure 5.1. Global Competitiveness Index: Quality of transport infrastructure, 2015-16

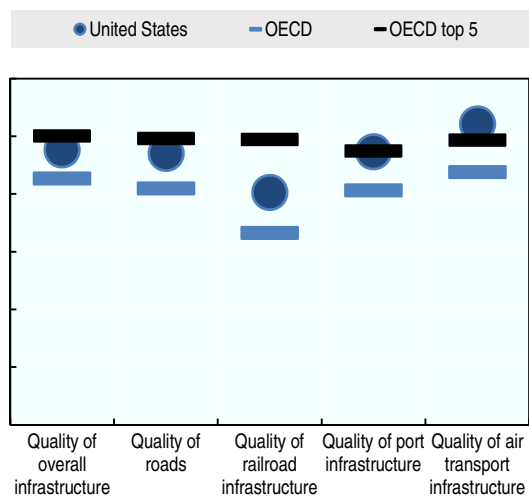
Scale 1 to 7 (best)

A. Index of transport infrastructure quality by country



Indices for EU28 and OECD are the simple average of member-country indices.

B. US index of transport infrastructure quality by component



OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Netherlands, Japan, Spain, France and Germany).

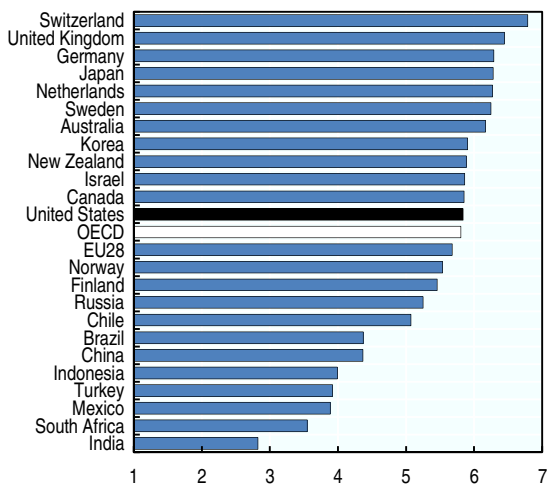
Source: World Economic Forum (2015), *The Global Competitiveness Report 2015-2016*, <http://reports.weforum.org/global-competitiveness-report-2015-2016/>.

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Figure 5.2. Global Competitiveness Index: Quality of electricity and telephony infrastructure, 2015-16

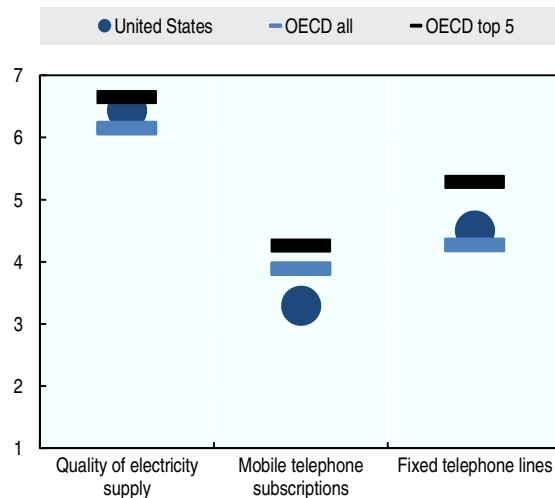
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A. Index of electricity and telephony infrastructure quality by country



Indices for EU28 and OECD are the simple average of member-country indices.

B. US index of electricity and telephony infrastructure quality by component

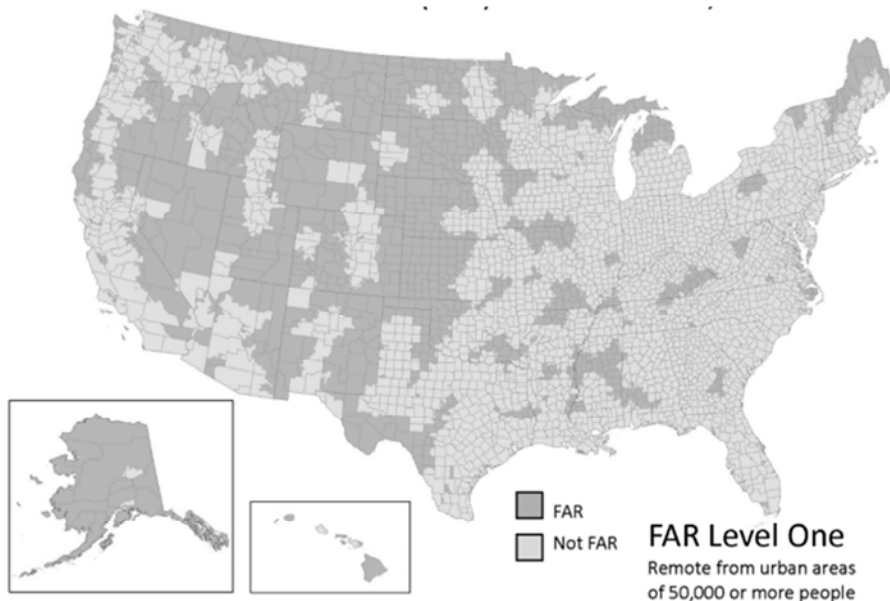


OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Switzerland, Luxembourg, Austria, United Kingdom and Iceland).

Source: World Economic Forum (2015), *The Global Competitiveness Report 2015-2016: Full data Edition*, <http://reports.weforum.org/global-competitiveness-report-2015-2016/>.

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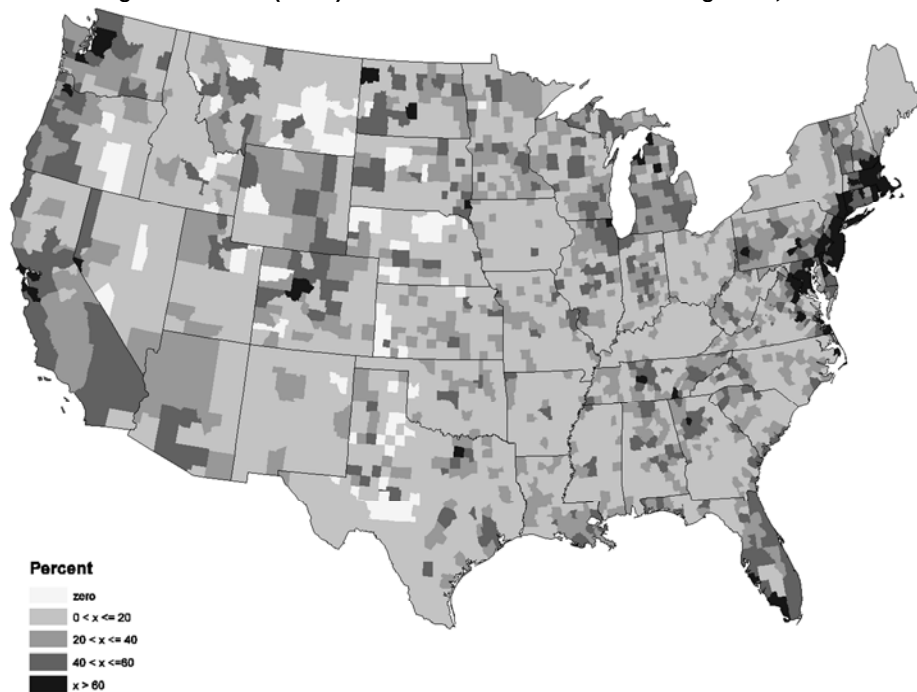
Figure 5.3. Access to urban areas, 2010



FAR level one includes ZIP code areas with majority populations living 60 minutes or more from urban areas of 50 000 or more.

Source: USDA Economic Research Service, using data from the US Census Bureau and ESRI.

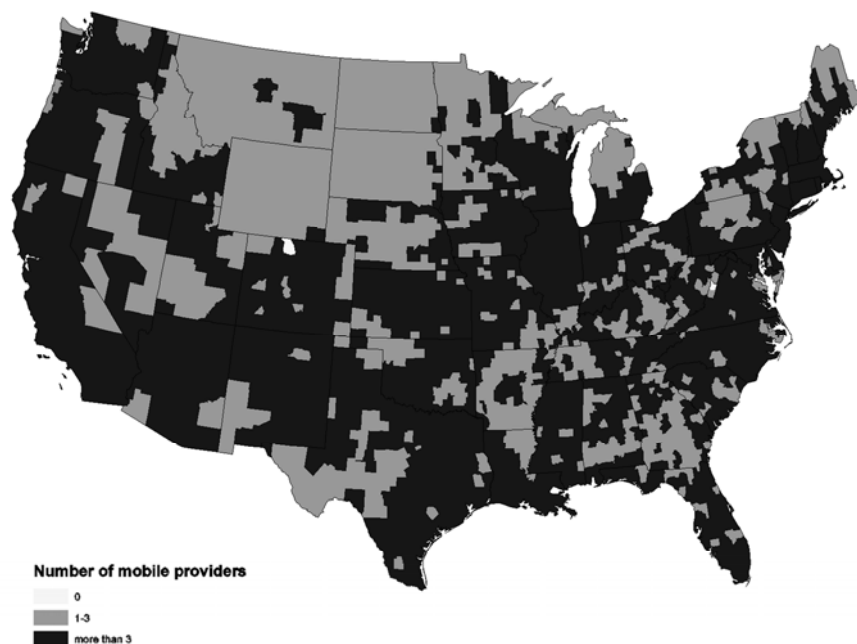
Figure 5.4. Fixed (wired) broadband access at 1.5 MBPS or greater, 2014



MBPS: megabits per second.

Source: USDA Economic Research Service, using data from the National Broadband Map, Federal Communications Commission.

Figure 5.5. Wireless broadband access at 1.5 MBPS or greater, 2014



MBPS: Megabits per second.

Source: USDA Economic Research Service, using data from the National Broadband Map, Federal Communications Commission.

Agricultural transportation

Because of the size of the country, and the often great distances between agricultural production regions, export ports, and domestic centres of consumption, investments in transportation have played an important role in the development of agricultural markets and in spurring investments in agriculture. Indeed, improvements in rail and ocean transportation, by reducing the costs of distance, played a critical role in the 19th century expansion of agriculture and settlement of the American West (Harley, 1978).

Almost all agricultural products, from grains to live chickens to milk, leave farms on trucks. Once they enter the transportation network, they may travel by truck, rail, water (usually barge), and even air. For example, just under half of cereal grains, by weight or value, moves from wholesalers, elevators, and other off-farm storage by truck, although these tend to be short-haul moves (Table 5.1). Long-distance shipments move by rail or, where available, by water.

Among other farm products, lower-value (per tonne) bulk commodities move by rail and by water for long-distance movements. Trucks carry higher value commodities, measured by value per tonne, often for short distances. Air is used for very high value perishable commodities — certain fruits and vegetables, for example — traveling long distances (Table 5.1 covers domestic shipments only). Live animals travel almost exclusively by truck, and typically for fairly short distances, while meat, poultry, and fish products also travel almost exclusively by truck, except for some very high value long-distance air shipments.

Table 5.1. Agricultural transportation: selected commodities and modes, 2012

Commodity class and mode of transportation	Value	Quantity	Value per tonne	Mean distance shipped
	Million USD	'000 tonnes	USD/tonne	Miles
Cereal grains				
All modes	130 140	479,064	272	202
Truck	62 606	224 475	279	94
Rail	48 004	184 749	260	670
Water	15 148	54 250	279	711
Farm products (excluding cereal grains, animal feed, forage products and livestock)				
All modes	197 793	218 995	903	505
Truck	145 612	135 713	1 073	182
Rail	14 154	26 720	530	1 189
Water	16 540	31 807	520	1 441
Air	1 159	139	8 338	2 135
Truck and Rail	9 931	15 212	653	778
Truck and Water	4 781	8 903	537	686
Live animals and live fish				
All modes	6 390	2 237	2 856	195
Truck	6 057	2 194	2 761	160
Meat, poultry, fish				
All modes	302 153	90 090	3 354	184
Truck	296 913	88 642	3 350	142
Air	864	72	12 000	2 692

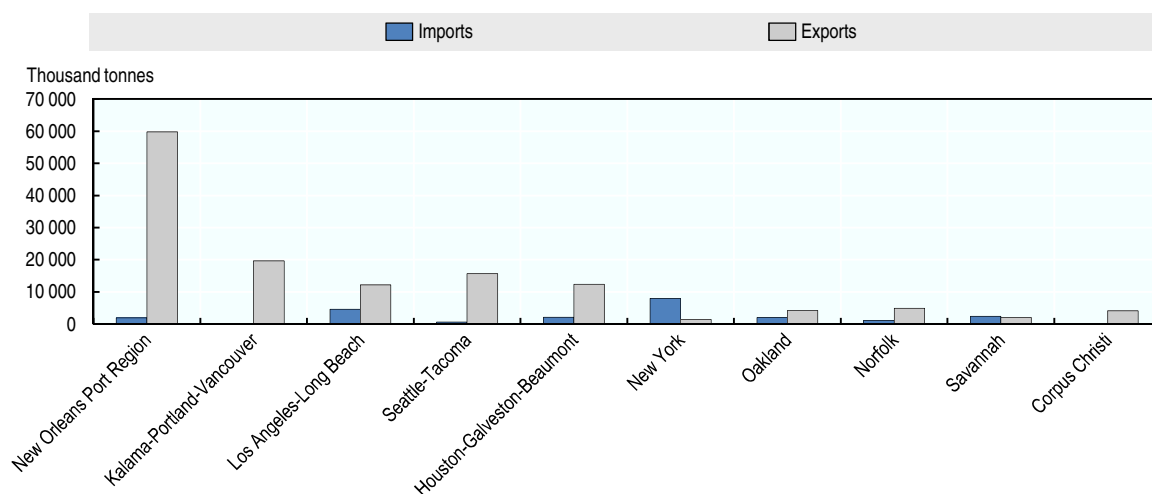
The survey covers domestic shipments originating in manufacturing or wholesaling establishments (such as grain elevators) but does not survey farms.

Source: US Census Bureau (2012), *Commodity Flow Survey*. www.census.gov/econ/cfs/.

Some US exports move by rail and truck to Mexico and Canada, and some high-value trade moves by air. However, most export tonnage moves through ports on the Atlantic, Pacific, and Gulf of Mexico coasts (Figure 5.6). The New Orleans port region, including locations and facilities along the Mississippi River near New Orleans, accounted for 40% of US agricultural exports by tonnage, primarily bulk commodities like grains and oilseeds bound for export. Pacific Northwest ports, including the Columbia River ports of Kalama and Vancouver in Washington, and Portland in Oregon, as well as Seattle and Tacoma on Puget Sound in Washington, accounted for another 24%. The New Orleans and Columbia River ports are served by inland waterways as well as railroads, making them ideal venues for bulk exports.

Thus the United States relies heavily on an effective railroad and waterway network for the long-distance movement of bulk commodities, especially grains, from elevators to ports for export. Trucks move farm commodities to nearby processing plants and elevator/storage facilities, and they move food products from processing plants to distributors and retailers. A well-maintained highway network is essential for these movements.

Figure 5.6. Ten largest US ports by volume of agricultural trade, 2011



Source: USDA (2015), Agricultural Marketing Service. <http://dx.doi.org/10.9752/TS041.04-2010>.

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Infrastructure development policies

Many different levels, agencies and programmes of government, as well as the private sector, are involved in development of different forms of infrastructure.

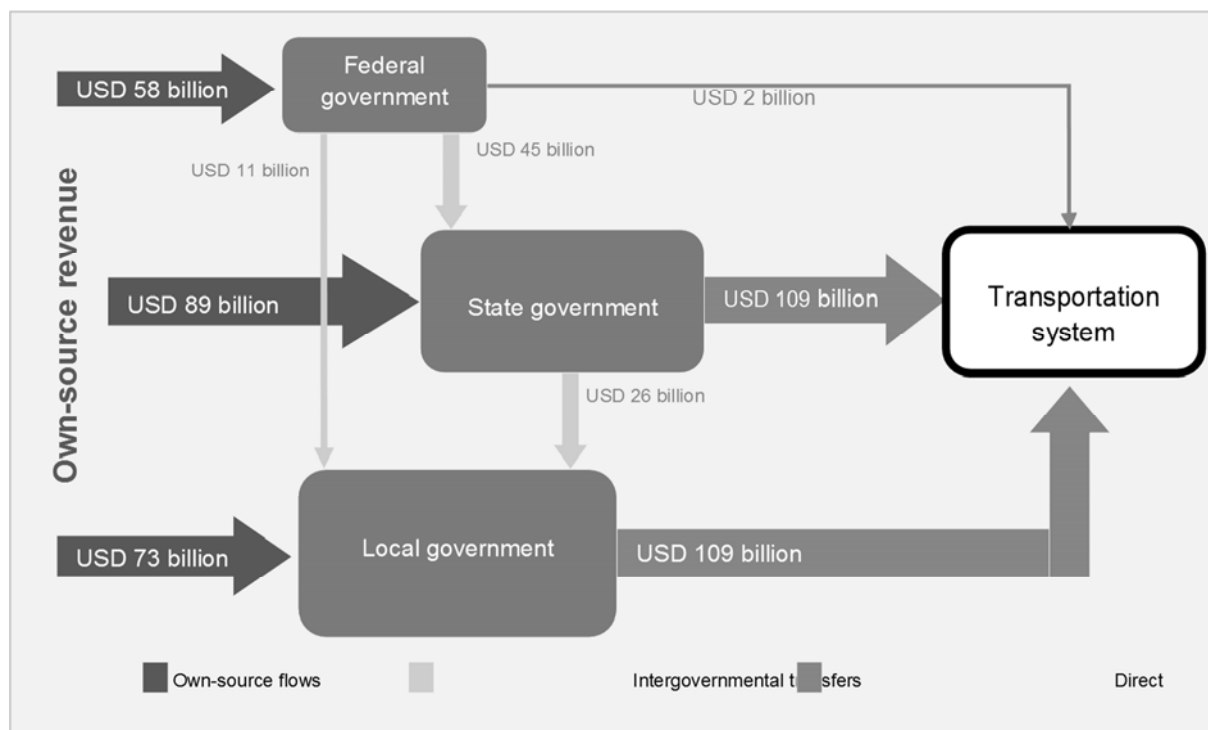
Highways and transit systems

In 2012, the Federal Government spent USD 58 billion for investments in highways and transit systems, while state governments spent USD 89 billion, and local governments (counties, cities and towns, and local public agencies) spent USD 73 billion (Figure 5.7). About half of the total funds for highways are used for capital investments, with the rest used for maintenance, highway and traffic services, highway safety, administration, and debt service.

Almost all funds spent by the Federal Government for highways were provided via transfers to state governments or local governments through the federal-aid Highway Program administered by the Federal Highway Administration (FHWA), while states also transferred USD 26 billion to local governments. The Interstate Highway System — a network of controlled-access, high speed roads that criss-crosses the country — is partly funded by the Federal Government but owned and maintained by

state governments. The Interstate System, which encompasses 47 856 miles of roads, accounted for one-quarter of all vehicle miles driven in the country. Local governments own and operate about 75% of the highway mileage in the United States. There are a few private toll highways and many private roads in the United States.

Figure 5.7. Spending on highways and transit by levels of government, 2012



Source: Pew Charitable Trust, www.pewtrusts.org/en/research-and-analysis/analysis/2015/02/24/funding-challenges-in-highway-and-transit-a-federal-state-local-analysis.

The primary source of revenue for federal and state spending on highways is the gasoline tax. Gas tax revenues of both the federal and state governments have declined over the past decade, due to changing driving habits, increased fuel efficiency of vehicles, and the fact that the federal gas tax and many state gas taxes are levied per gallon and have not increased for many years. The federal government and several states are increasingly relying on other sources of revenue to finance highway development, maintenance, and improvement, such as tolls, general funds, and bonds.

Despite declining revenues from gasoline taxes, the safety and conditions of highways and bridges generally improved between 2000 and 2010, although improvements have not been uniform as investments have targeted highways with greater traffic. For example, the share of rural interstate bridges classified as structurally deficient rose from 4.0% in 2000 to 4.5% in 2010, while the share of bridges in the entire National Highway System classified as structurally deficient declined from 23.7% to 21.4%.

Railroads

Most of the railroad tracks were built by private railroad companies in the 19th century using land grants from the federal government, and these companies and their successors still own and maintain the tracks and operate freight services on them. Railroads are used primarily to haul freight, and intercity passenger train traffic is limited mostly to the Northeast corridor between Boston and Washington. In 2010, US freight trains hauled more freight (in tonnes) than all of the European Union and hauled nearly

eight times the number of tonne-miles of freight (Furtado, 2013). Most passenger trains, which are operated by public agencies, use tracks owned by freight railroad companies.

Railroad companies are subject to various federal and state government regulations, but maintenance and improvements of railroad infrastructure are financed out of their own resources. This affects the competitiveness of railroads relative to trucks and barges as modes of hauling freight, since investments in highways and waterways are largely publicly financed (US General Accounting Office, 1991).

The Staggers Rail Act of 1980 was the culmination of a series of major regulatory reform initiatives in airlines, trucking, pipeline and rail transportation during 1975-80, and presaged later reforms in electricity and telecommunications. The Act relaxed regulation of rail rates, primarily by allowing railroads and shippers to negotiate contracts for transportation, and provided railroads with greater flexibility in providing services and abandoning track. The reforms tied rail rates more closely to shipment sizes and volumes of traffic, which affected rail costs, and the resulting rate structure induced shippers to aggregate shipments into larger shipments on mainlines, and to shift to trucks for short-haul shipments. After passage of the Act, the size of the network contracted as railroads abandoned secondary lines, and railroad employment fell, but output rose and various measures of productivity rose sharply (Gallamore and Meyer, 2014). Real rates fell, and railroads expanded investments in track and facilities, leading to improved services as well.

Agricultural shippers — primarily grain shippers but also shippers of fertiliser and agricultural chemicals for sale to farmers, realised lower rates for longer-haul and larger shipments, and they responded by reorganising rail shipments to realise economics of scale (MacDonald, 1989). However, in some parts of the country — particularly in the Northern Great Plains — agricultural shippers are distant from the competition that waterways offer to railroads, and mergers have reduced to number of competing railroads to just one or two. The option of using long-haul, albeit high-cost, truck transportation constrains the rates that railroads can charge, but they nonetheless have market power and the issue of rail competition remains an important one for agricultural shippers.

Ports and waterways

The US Army Corp of Engineers (USACE) is the primary agency responsible for constructing and maintaining investments in the nation's inland waterways and deep-water port facilities, including harbours, locks, canals, dams, levees, and other investments. The USACE operates and maintains 25 000 miles of navigable inland waterways in 41 states. The President's Budget for Fiscal Year (FY) 2016 requested USD 4.7 billion for USACE's Civil Works programmes, including about USD 1 billion for inland waterways and USD 1 billion for coastal waterways.²

High volumes of US agricultural exports move through the New Orleans Port Region (Figure 5.6), and most of that arrives at ports on barges moving through the Mississippi River System. In turn, much of the grain traffic originates on the Upper Mississippi River and the Illinois Waterway, which flows into the Mississippi. Navigation on each depends on a set of locks, and on water depth and flow in the rivers, which are partly influenced by public investments. Waterway navigation has also created ecological costs along the rivers, which the USACE is attempting to address (Casavant et al., 2010). A small amount of traffic also flows along the Missouri River, where management of water levels impacts recreational, environmental, hydroelectric power, flood control, and navigation uses. Management of Missouri River water levels is critical to Mississippi River traffic, because the Missouri system can store water for later release to the Mississippi, augmenting flows on that system. The USACE must balance a set of competing interests and investment options in managing navigation and water quality on the rivers.

Most of the funding for inland waterways comes from general funds, while a portion comes from the Inland Waterways Trust Fund, which is financed by a fuel tax levied on commercial users of waterways. Nearly all of the funding for coastal waterways comes from the Harbor Maintenance Trust Fund, which is financed by a tax on shippers, based on the value of commodities shipped through ports.

Other funds invested by USACE, such as investments for flood prevention and ecosystem restoration and stewardship, also contribute to the quality of waterways and ports.

The United States has 360 commercial ports, including more than 150 deep-draft seaports under the jurisdiction of 126 public seaport agencies. Seaport authorities develop and maintain terminal facilities for transferring cargo between different transportation modes. Public port authorities work closely with private industry to invest in terminals and other maritime facilities.

Airports

Almost all commercial airports in the United States are publicly owned by local or state governments, or by public entities such as airport authorities or multipurpose port authorities (Tang, 2014). In 1996, Congress established the Airport Privatization Pilot Program (APPP) to promote privatisation of airports, but by 2014 only two airports had privatised (via long-term leases of the airport to a private company), and one of those — Stewart International Airport in Newburg, NY — reverted to public ownership in 2007.

Although almost all commercial airports are publicly owned, private companies play major roles in their management, financing and operation. Private airline companies lease space in airport terminals, and in some cases are involved in financing terminal improvements. As lessees of airport facilities, airline companies also can have substantial influence on airport investments. Private companies are also usually involved in providing airport services, such as parking garages, cleaning services, restaurants, and other services.

The Federal Government plays a major role in regulating airport operations and safety through the operations of the Federal Aviation Administration. Through the Essential Air Service programme, the Department of Transportation subsidises commercial airline services to rural communities that were served by airlines prior to airline deregulation and that otherwise would not be served.

Electricity

Most electricity is generated by private investor-owned utilities. The remainder is generated by municipal public utilities, cooperatives, federal power marketing agencies such as the Tennessee Valley Authority and the Bonneville Power Administration, state power marketing agencies such as the New York Power Authority, and private nonutility power producers. Nonutility power producers do not distribute electricity to final consumers; they sell electricity to electric utilities or to power marketers.

Historically, most investor-owned electric utilities were vertically integrated monopolies, involved in electric power generation, transmission (the movement of electricity from power plants to transformer substations in high voltage lines), and distribution (the movement of electricity from substations to consumers in low voltage lines). The retail prices charged by investor-owned electric utilities to consumers have long been regulated by state public utility agencies, while interstate wholesale prices for electricity are regulated by the Federal Energy Regulatory Commission (FERC).

Transmission lines are owned by investor-owned utilities, electric cooperatives, publicly-owned utilities, regulated transmission owners, and transmission merchant companies (Brown and Sedano, 2004). The transmission grid in the United States and Canada is divided into five subsystems, called interconnections, including one in the western United States and Canada and northern Baja California, one in the eastern United States and parts of Canada, one in Quebec and parts of the north-eastern United States, one in Texas, and one in Alaska. These interconnections transmit synchronised alternating current (AC) electric power within each subsystem, but are not synchronised with each other. Transmission between these systems requires conversion of AC power to direct current (DC) and then reconversion to AC requiring expensive equipment. Hence most electric transmission occurs within these interconnections; as there is limited capacity for transmission between them.

The reliability of the eastern interconnection is managed by several regional reliability councils, while each of the other interconnections has a single reliability council. Operation of the transmission

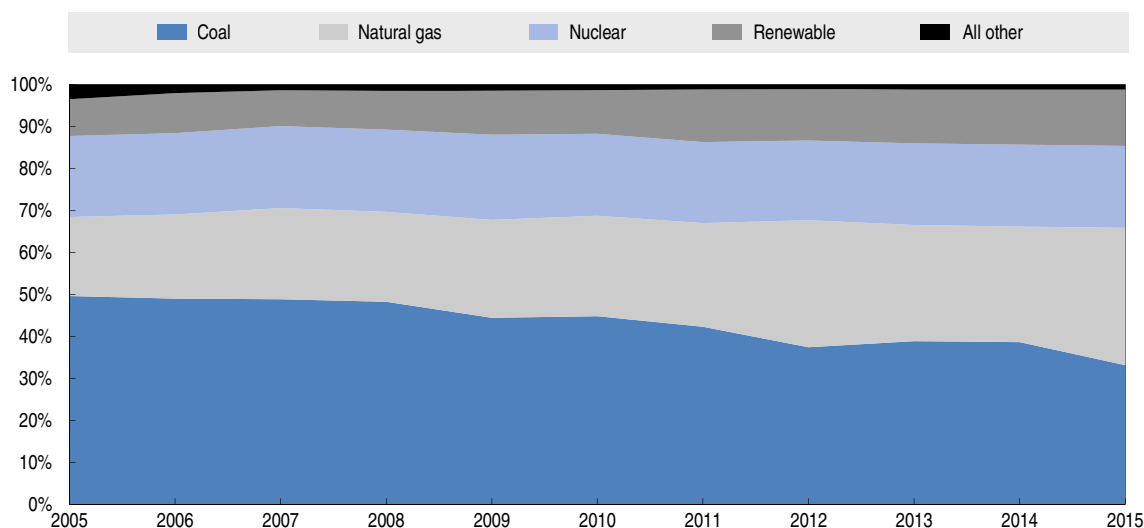
grid is regulated by the North American Electric Reliability Corporation (NERC), a not-for-profit international regulatory authority, subject to oversight by FERC and government authorities in Canada. Non-discriminatory access to the transmission grid is controlled by a system of Regional Transmission Operators (RTOs) and Independent System Operators (ISOs) that are independent of power generators and utilities, and regulated by FERC.

The integrated and regulated industry structure has gradually changed in recent decades (Joskow, 2000). A deregulated wholesale market in electricity sales among utilities began to develop in the 1970s, and independent power producers began to enter the generation market and sell to utilities in the 1980s. After enactment of the Energy Policy Act of 1992, several states pursued deregulation of the electric industry, under which wholesale prices would be fully deregulated, and some types of retail prices would also be deregulated. As of January 2016, 16 states and the District of Columbia had deregulated electricity markets, while 7 states have suspended deregulation efforts. Concerns about manipulation of electricity supplies and prices, as occurred after a partial deregulation in California, may have limited wider adoption of deregulation.

Electricity generation has undergone another important shift in recent years: the movement away from coal as a fuel source and toward natural gas and wind power (Figure 5.8). A decade ago, half of US electricity generation was powered by coal, while natural gas accounted for less than a fifth. In 2015, coal and natural gas each accounted for one third, while the share of renewables rose from 9 to 14%, largely through the expansion of wind sources. The shift to natural gas has in turn been driven by new domestic production facilitated by fracking technologies, which have sharply reduced natural gas prices.

Figure 5.8. US electricity generation, by fuel source, 2005-15

Net generation by utility scale electric generation facilities (million megawatt hours)



Source: US Department of Energy (2016), www.eia.gov/.

StatLink  <http://dx.doi.org/10.1787/888933408604>

Changes in the electricity sector, particularly in generation, have provided some new opportunities for US farmers. Almost 97 000 farms received income from energy leases (natural gas, oil, or wind) in 2014, with a median annual payment of nearly USD 6 000. Most of the recipients leased land for the placement of wind turbines. There has also been interest in the use of anaerobic digesters on dairy and pig farms, to capture methane gas from manure for use either for on-farm electricity generation or for sale to utilities as a feedstock for commercial electricity production (Key and Sneeringer, 2011). Digesters are privately profitable only for very large farms with willing buyers of excess electricity production. However, there is considerable policy interest in supporting them — through capital subsidies, direct payments, or renewable fuel purchase mandates imposed on utilities — as a way to reduce greenhouse gas emissions. By 2014, 35 swine and 244 dairy farms had adopted digesters; the dairy adopters tended to be quite large, representing about 5.6% of the national inventory of milk cows.

Telecommunications

Telecommunications includes information and communication technologies (ICT) — telephone, telegraph, computers, cable TV, mobile phones, radio, other electronic devices, and the Internet. In the United States, these technologies are provided by private industry that ranges from large private corporations to small member-owned rural cooperatives (and number into the thousands), with a few municipally-owned operations in the mix.

The industry is regulated under the Communications Act of 1934, which has been amended over the years. The last major revision took place under the Telecommunications Act of 1996. The law sets out the role of the federal, state, and local governments and covers most aspects of the ICT industry. The 1934 Act mandates and instructs the Federal Communications Commission's regulatory authority over the industry, except where state and local government has authority. Each of the 50 states has a public utility commission that regulates the state's industry within the scope allowed under the 1934 Act.

Historically federal, state, and local government telecommunication infrastructure programmes have mostly leveraged private funds to increase the availability of communication service, but recently some programmes have been designed explicitly to increase household Internet participation. The Rural Utility Service (RUS) of the US Department of Agriculture (USDA) has been the lead agency for rural Internet policy and has three on-going Internet programmes: 1) traditional federal Rural Telecommunication Infrastructure Program requiring all facilities to be broadband capable; 2) farm bill Rural Broadband Program (authorised by the five-year farm bills, the Agriculture Act of 2014 is the latest of these); and 3) Community Connect Broadband Grant Program.

The US Department of Commerce's National Telecommunications and Information Administration (NTIA) and RUS also jointly administered broadband programmes resulting from the American Recovery and Reinvestment Act of 2009 that has led to, approximately, a USD 7 billion investment in broadband infrastructure. Recently the Federal Communications Commission (FCC) reformed the Universal Service Fund and created the Connect America Fund that provided USD 300 million in phase I monies for private investment in rural broadband system development. In September 2015 the FCC announced a further USD 9 billion over six years in phase II monies awarded to service providers. Although this is a substantial investment, it is less than one percent of all communication infrastructure investment in the country.

Regional development policies and programmes

Regional agencies such as the Tennessee Valley Authority (TVA), the Appalachian Regional Commission (ARC), the Delta Regional Authority (DRA), and the Denali Commission also are involved in infrastructure investment and other economic and community development activities.

The TVA is a corporate agency of the Federal Government established in 1933 to help improve the quality of life in the Tennessee Valley, a region that was hit hard by the Great Depression. The

Tennessee Valley region includes most of Tennessee, significant parts of Alabama, Mississippi, and Kentucky, and small portions of Georgia, North Carolina, and Virginia.

The TVA was the first large regional planning agency of the Federal Government. Its mandate was to promote navigation, flood control, electricity generation, fertiliser manufacturing, restoration of degraded lands, and economic development in the Tennessee Valley. TVA operates the nation's largest public power system. Dams and hydroelectric facilities were the initial focus of TVA's energy production, but by the mid-1950s coal surpassed hydropower as TVA's primary source of energy, and in the 1960s TVA constructed its first nuclear power plant. In 2015, about 40% of TVA's electricity production was from coal, 33% from nuclear, 13% from natural gas, 10% from hydropower, and 3% from renewables (TVA, 2015). In addition to electricity generation and distribution, TVA has programmes related to environmental stewardship and economic development. For example, TVA works with regional, state, and community organisations to offer site selection services, incentives, research and technical assistance to help companies locate and expand operations in the Tennessee Valley. TVA is financed by its own operating revenues, primarily from its sales of electricity, and by borrowing. In 2015 TVA's revenues were USD 11 billion and its expenses were about USD 10 billion (TVA, 2016).

The ARC was established in 1965 as part of President Johnson's War on Poverty to promote economic development in the impoverished Appalachian region, which includes all of West Virginia and parts of 12 other states. The ARC is a federal-state partnership in which the governors of the region's states have a role in selecting projects for funding, along with the Federal Government. The 1965 ARC Act appropriated funds for highways, hospitals and treatment centres, land conservation and stabilisation, land restoration, flood control and water resource management, vocational education facilities, and sewage treatment works. The ARC currently focuses on: 1) investing in entrepreneurial and business development strategies; 2) improving the education, knowledge, skills, and health of Appalachian residents; 3) investing in infrastructure — especially broadband, highways, and water/wastewater systems; 4) strengthening community and economic development potential by leveraging the region's natural and cultural heritage assets; and 5) building the capacity of leaders and organisations to innovate, collaborate, and advance community and economic development. The ARC is funded by annual appropriations from Congress, which are USD 146 million for 2016. It also seeks to leverage other public and private investments in the Appalachian region.

The Denali Commission was established in 1998 to address infrastructure, workforce, and economic development needs of remote communities in Alaska. Like the ARC, it is a federal-state partnership. It is funded by annual appropriations, interest on the Trans-Alaska-Pipeline-Liability Fund, and other federal funds; these funds amounted to about USD 24 million in 2014 (Denali Commission, 2015). The Denali Commission's programmes focus on investments in transportation and energy infrastructure, health facilities, training, and government coordination.

The DRA was established in 2000 to promote economic development in the impoverished Mississippi Delta region, which includes parts of eight states in the vicinity of the Mississippi River. Like the ARC, the DRA is a federal-state partnership and is funded by annual appropriations, which amounted to USD 12 million in 2015 (DRA, 2015). The DRA targets most of its grant funds to economically distressed communities, and focuses on investments in small business and entrepreneurship, workforce development and training, basic public infrastructure (such as water and sewer systems, electric and gas utilities, broadband delivery, and solid waste landfills) and transportation infrastructure. The DRA works in partnership with other federal and state agencies, seeking to leverage other sources of funds. Contributing to the potential leverage of DRA funds is the fact that the DRA Act allows DRA funds to be used to supplement other federal programme funds above the maximum amounts of federal support authorised by other applicable laws (Pender and Reeder, 2011).

Several other regional development commissions have been authorised by Congress, including the Northern Border Regional Commission (NBRC), the Northern Great Plains Regional Authority, the Southeast Crescent Regional Commission, and the Southwest Border Regional Commission. Of these, only the NBRC has ever received appropriations, including USD 5 million in 2015.

The NBRC has been in operation since 2010, and focuses on grants to help address community and economic development needs of economically distressed areas of the northern forest region, which includes parts of Maine, New Hampshire, Vermont, and New York. NBRC grants focus on transportation and basic infrastructure, job skills training and entrepreneurial development, comprehensive strategy development, advanced technologies and telecommunications, and sustainable energy solutions. Like the DRA and other regional development commissions, the NBRC seeks to leverage other public and private investments with its limited amount of funds.

Several other federal initiatives have also promoted regional development, including:

- Empowerment Zones and Enterprise Communities (EZ/EC), established in the early 1990s and providing grants and tax incentives to promote development in selected high poverty urban communities and rural regions;
- Renewal Communities (RC), established in the 2000s with similar objectives to the EZ/EC programme, but limited to use of tax incentives to promote development in high poverty urban and rural RCs;
- Gulf Opportunity Zones (GO Zones), established after Hurricanes Katrina, Rita, and Wilma in 2005, to promote economic recovery and development in the regions affected by the hurricanes using tax incentives; and
- Place-based policies and programmes pursued by the Obama Administration without a need for authorising legislation, such as the Promise Zones initiative, which is targeted to high-poverty communities and provides preferential access to grants and technical assistance through selected federal government programmes.

Rural development policies and programmes

The USDA is the lead federal agency for rural development programmes, which are operated by USDA's Rural Development (RD) mission area. RD programmes seek to promote rural prosperity by providing direct and guaranteed loans, grants, and technical assistance to support development of rural businesses and cooperatives, utility infrastructure, and housing and community facilities through the Rural Business-Cooperative Service (RBS), the Rural Utilities Service (RUS), and the Rural Housing Service (RHS). Over the years, the share of assistance provided under grant and direct loan programmes has declined, while guaranteed loans have increased in importance. The total value of assistance (programme level) provided by RD programmes in 2015 was more than USD 38 billion (Table 5.2), with most of this in loans or loan guarantees. The budget authority (appropriations) required paying the costs of grants, unrecovered loans, salaries and expenses amounted to less than USD 3 billion in 2015.

By far the largest RD programme in terms of programme level is the Single Family Housing loan programme, which provided mortgage loans for single family dwellings in rural areas worth nearly USD 25 billion in 2015. However, almost all of these loans are expected to be repaid, so the budget authority required for the programme is only USD 66 million. The rural electricity programmes are the largest RD programmes to support investment in utility infrastructure (USD 5.5 billion programme level in 2015), but all of these loans are expected to be repaid by rural utilities, so no budget authority is required for these.

The largest RD programme in terms of budget authority is the Rental Assistance grant programme, costing over USD 1 billion in 2015. Rental Assistance payments are used to reduce the rents of low income families in multi-family rural housing projects financed by RHS loans to no more than 30% of their income. Other relatively large (in terms of budget authority) RD programmes include the Water

and Waste Disposal Program (which provides financing for rural communities to establish, expand or modernise water treatment and waste disposal facilities), the Business and Industry Guaranteed Loan Program (which guarantees up to 90% of the value of loans by commercial lenders to rural businesses), and the Rural Energy for America Program (which supports the President’s Climate Action plan by providing financing for the purchase of renewable energy systems, energy efficiency improvements, energy audits and feasibility studies).

Table 5.2. USDA rural development: Enacted programme levels and budget authority, 2015

Million USD

Agency Programme		Total programme level	Budget authority
RBS	Business and Industry Guaranteed Loans	920	47
	Rural Business Development Grants	24	24
	Rural Economic Development Loans/Grants	43	0 ³
	Value-added Producer Grants	11	11
	Rural Energy for America Program	88	47
	Biorefinery Assistance Guaranteed Loans	71	30
	Bioenergy for Advanced Biofuels	14	14
	Other RBS programmes	22	17
	Salaries and expenses	4	4
	Subtotal – RBS	1 216	200
RUS	Electricity Programs	5 500	0
	Telecommunications Programs	690	0
	Distance Learning and Telemedicine Programs	22	22
	Broadband Programs	34	15
	High Energy Costs Grants	10	10
	Water and Waste Disposal Programs	1 705	455
	Salaries and expenses	35	35
	Subtotal – RUS	7 996	537
RHS	Single Family Housing Loan Programs	24 900	66
	Multi-Family Housing Loan Programs	178	10
	Very Low-Income Repair Grants and Loans	55	33
	Farm Labor Housing Grants and Loans	32	16
	All Other Direct Housing Loans	20	0
	Rental Assistance Grants	1 089	1 089
	Community Facilities Loans and Grants	2 299	30
	Other RHS Programs	66	55
	Salaries and expenses	415	415
	Subtotal – RHS	29 054	1 714
	Salaries and expenses at RD level	224	224
	Total Rural Development	38 490	2 675

RBS is Rural Business Services; RUS is Rural Utilities Service; and RHS is Rural Housing Services. 2015 is fiscal year (FY) 2015.

Source: USDA (2016), USDA FY 2017 Budget Summary. www.obpa.usda.gov/budsum/fy17budsum.pdf.

Many other federal agencies also provide assistance to rural communities through various programmes, including programmes of the Department of Transportation (DOT), the Small Business Administration (SBA), the Commerce Department (especially the Economic Development Administration), and many others. In 2005, the US Government Accountability Office (GAO, 2006) reviewed 86 Federal Government programmes in ten federal agencies and three regional commissions that provide economic development assistance. GAO found that these programmes provided in total (to both urban and rural areas) about USD 200 billion in funding from 2002 to 2004, with the largest share of funds to rural areas provided by programmes of USDA, Department of Interior, and the regional commissions, while the largest amount of funds was provided to rural areas by DOT programmes, followed by USDA programmes. Although a smaller share of funds went to rural areas under DOT programmes than under USDA programmes, the total volume of funds provided under DOT programmes was substantially larger.

State and local governments also influence rural development through various programmes, investments and tax incentive policies. Some states provide specific incentives to promote business investments in rural areas. For example, Florida offers increased incentive awards and lower wage qualification thresholds through its business incentive programmes for businesses investing in its rural counties, and also operates a Rural Community Development Revolving Loan Fund and a Rural Infrastructure Fund to help address special needs that business face in rural areas.

Labour market policy

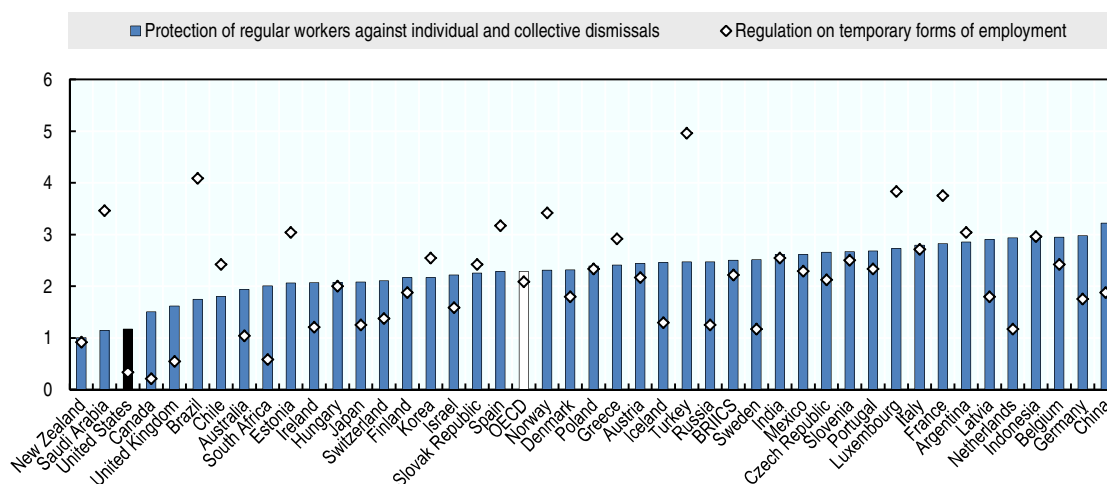
Public policies affect the size, flexibility, and skills of the workforce available for agriculture. Government labour market policies affect the ease with which workers can move into and out of agricultural employment as well as the conditions of employment. It thus influences employment composition and labour mobility, in particular by facilitating (or discouraging) labour to adapt to new circumstances. It can play an important role in facilitating structural adjustment, including farm consolidation, by assisting excess labour in farming to exploit more remunerative non-farm income and employment opportunities. Policies on skills improvement and on international mobility of human resources can affect innovation and knowledge transfer through exchange of skills and skilled labour. Structural adjustment allowing younger and better educated farmers to enter the sector, and skills improvement policies are expected to improve the adoption of sustainable practices.

Labour market legislation and efficiency

The United States has one of the least restrictive employment protection legislation among G20 countries, in particular for temporary forms of employment (Figure 5.9). As a result, the US labour market is ranked by business leaders as one of the most efficient in the OECD area (Figure 5.10A). This gives the agri-food sector the flexibility to adjust quickly to changes in labour and skills needs. Business leader opinion surveys place the US labour market among the top five performers in most criteria, in particular the capacity to attract and retain talent (Figure 10B). This is particularly important for agricultural innovation as the US innovation system attracts well-qualified nationals and foreigners.

Figure 5.9. OECD indicators of employment protection legislation 2013¹

Scale from 0 (least) to 6 (most) restrictive



The OECD Indicators of Employment Protection refer to labour market flexibility regarding the procedures and costs required to dismiss workers and the procedures involved in hiring workers.

Data for Argentina, Brazil, China, India, Indonesia, Russian Federation, Saudi Arabia and South Africa represent 2012.

Source: OECD (2014), Employment Protection Database. www.oecd.org/employment/protection.

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The general employment legislation affects agribusiness companies, but also the farming sector to the extent many farmers pursue off-farm work, even those who operate large farms. One third of the principal operators of farms with between USD 500 000 and USD 1 000 000 in sales worked off the farm in 2012, and 27% of principal operators with at least USD 1 000 000 in farm sales. Moreover, many farm spouses hold off-farm jobs. Consequently labour market policies that cover all industries also matter to farmers.

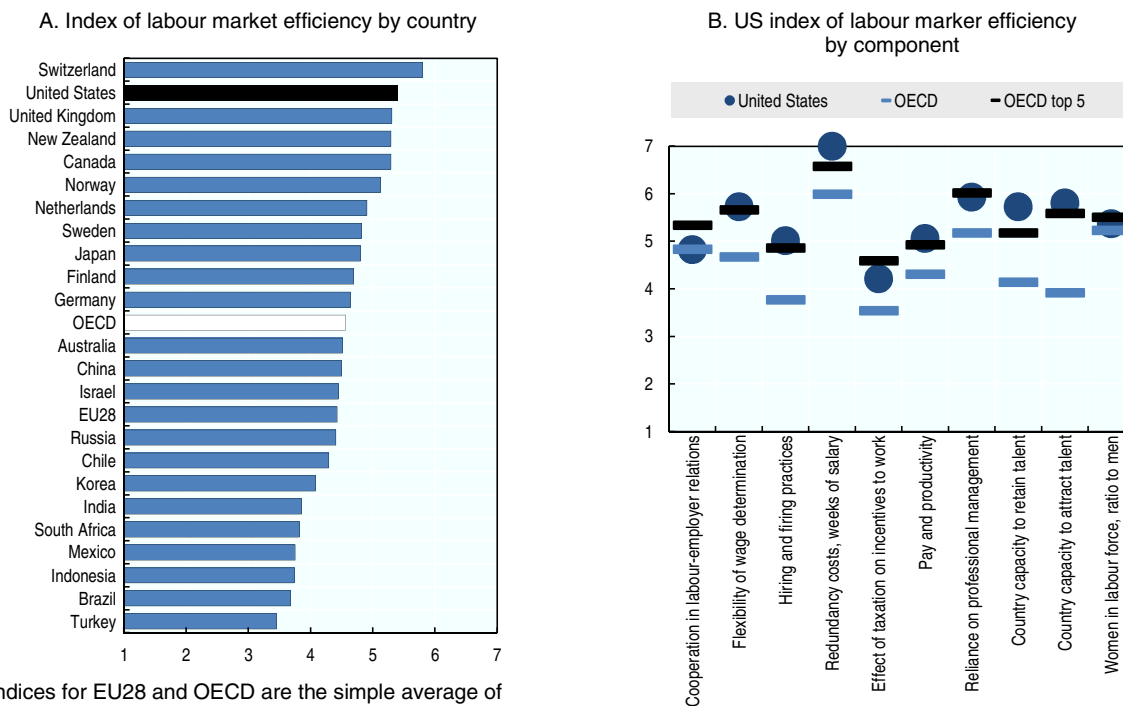
Some labour market policies are of specific interest to agriculture. In 1948, 8 million people were employed in US agriculture — about 12% of total civilian employment. Then, and for years thereafter, labour-market related policies included policies to ease the transition of farmers and farm workers into non-farm employment. However, that sectoral transition was largely completed by the 1970s, and agricultural employment has been steady for the last decade. In addition, there are specific laws regulating the terms and conditions of agricultural employment (see below).

Today, the sector employs about 1 million full-time equivalent wage and salary workers (including those directly hired and those brought to farms by labour contractors). In addition, there are about 3 million farm operators who do not draw a wage or salary; most of these operate very small farms, but their full-time equivalent employment amounts to 1.57 million workers (using a definition of full-time equivalent of 2 040 hours per year).

About half of all hired farm workers, and as many as three-quarters of hired crop farm workers, are foreign-born. As a result, immigration policies matter for agriculture. Policies that encourage the development of labour-saving technologies also matter, and are intertwined with immigration policy.

Figure 5.10. Global Competitiveness Index: Labour market efficiency, 2015-16

Scale 1 to 7 (best)



Indices for EU28 and OECD are the simple average of member-country indices.

OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Switzerland, United States, United Kingdom, New Zealand and Canada).

Source: World Economic Forum (2015), *The Global Competitiveness Report 2015-2016: Full data Edition*, Geneva 2015. www.weforum.org/reports/global-competitiveness-report-2015.

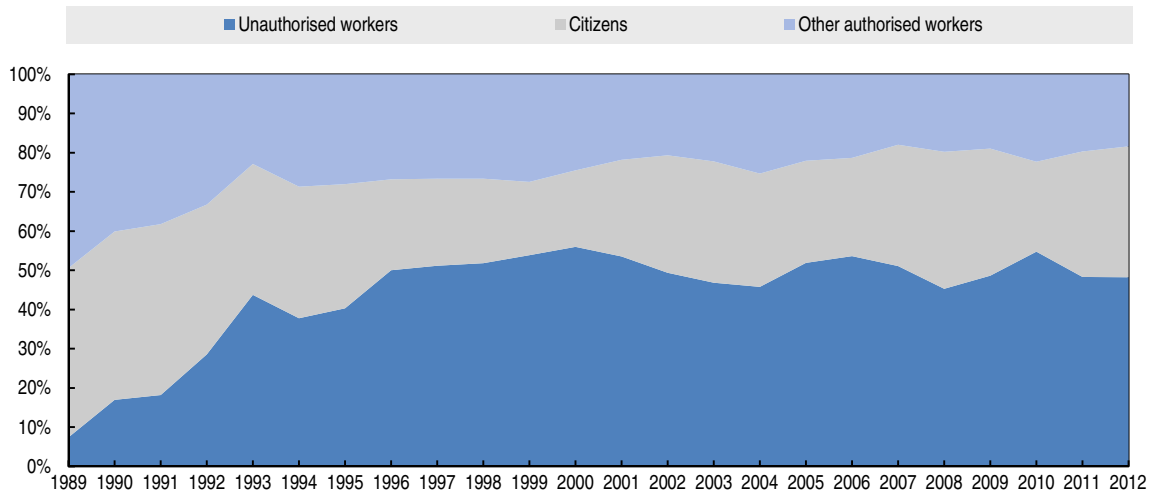
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Immigration policy with implications for agriculture: Programmes and utilisation rates

Unauthorised immigrants, primarily from Mexico, but increasingly from Central America, provide roughly half of hired labour services to crop agriculture, and an unknown but significant share of labour services in livestock, especially on dairy farms. The level of enforcement at the border and in the interior influence the size of this pool of unauthorised workers as do demographic and economic trends in sending countries. The share of unauthorised workers in the total hired labour crop workforce grew sharply between 1993 and 2000, and has since remained stable (Figure 5.11).

The importance of unauthorised workers varies across crops (Figure 5.12). They accounted for 22% of hired workers in field crops in 2005-09, while US citizens account for 64%. At the other extreme, unauthorised workers accounted for 61% of hired workers on vegetable farms and 67% of those on fruit farms.

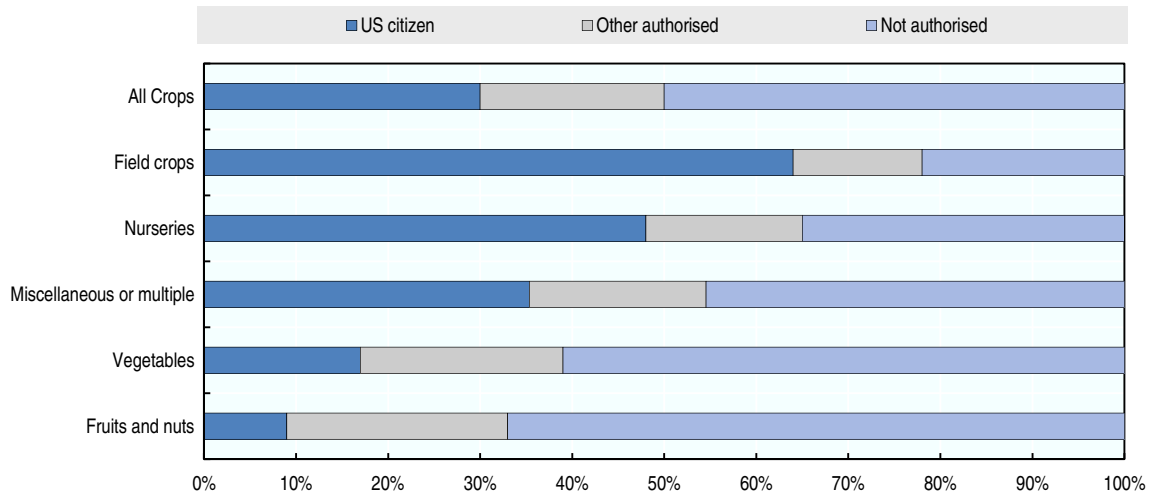
Figure 5.11. Trends in authorisation status of hired US crop workers, 1989-2012



Source: USDA Economic Research Service analysis of US Department of Labor (2015), National Agricultural Workers Survey www.doleta.gov/agworker/naws.cfm.

StatLink  <http://dx.doi.org/10.1787/888933408638>

Figure 5.12. Unauthorised workers account for half of all hired labour on crop farms, 2005-09



Source: USDA Economic Research Service analysis of US Department of Labor (2015), National Agricultural Workers Survey, 2005-09. www.doleta.gov/agworker/naws.cfm.

StatLink  <http://dx.doi.org/10.1787/888933408644>

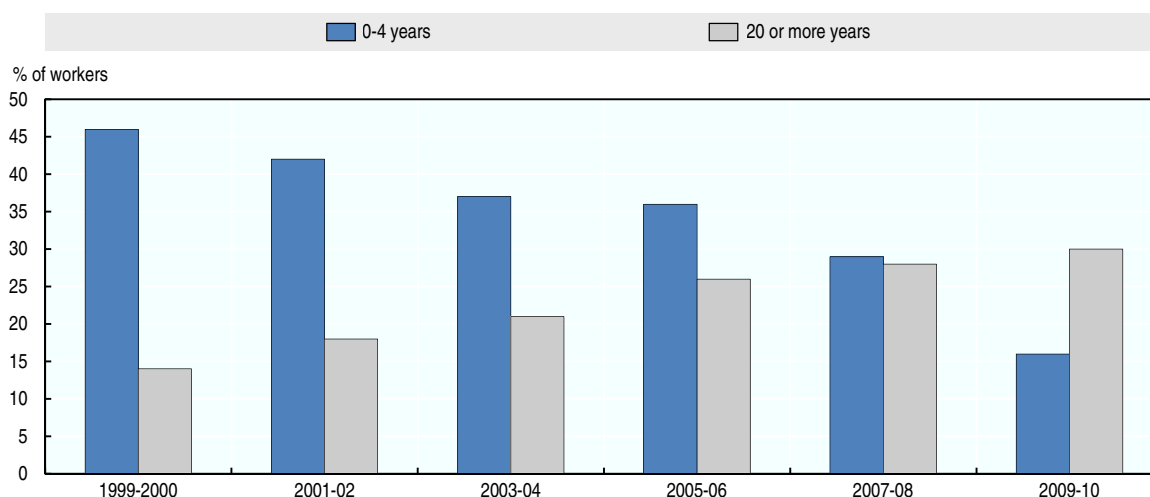
The nature of the hired farm work force has changed since 2000, due to new immigration laws, more vigorous enforcement of immigration laws, and changes in the incentives to migrate from Mexico. Policy was strongly affected by the September 2001 attacks on the United States. The states of Alabama, Arizona, Georgia, Mississippi, North Carolina, South Carolina and Utah now require almost all private employers to verify legal immigration status via a federal online system as a condition of employment; many other states have imposed this requirement for state and local governments or their contractors, or otherwise strengthened immigration status documentation requirements.

Net migration slowed in the 2000s, so that the hired farm workforce became older and more settled. There was some decline in foreign-born workers, from 83% of hired workers in 1999-2000 to 71% in 2011-12. But the foreign born workforce also became older and more stable. Among foreign-born farm workers in 1999-2000, 46% reported migrating within the last four years, while 14% reported being in the country for at least 20 years (Figure 5.13). The share of recent immigrants fell steadily over the next decade, reaching 16% in 2009-10, while the share of long-term immigrants rose to 30% by 2009-10.

In addition, the patterns of migration shifted. The number and share of hired crop workers who migrate during a year, either from farm-to-farm (“follow the crop”), or from home-to-farm (“shuttlers”), fell sharply (Figure 5.14). The fractions settled in one place rose from 42% of the workforce in 1998 to 74% by 2009. In particular, unauthorised follow-the-crop migrants were less willing to move farm-to-farm because of the risks of discovery and deportation (Fan et al., 2015).

These changes in the hired workforce led to concerns among some growers about labour supply: in particular, fruit and vegetable growers rely on migrant workers to meet sharp seasonal fluctuations in the tempo of work. These concerns led them to seek political accommodation through changes in policy through an expanded programme for temporary authorised workers; however, no new programme has been passed.

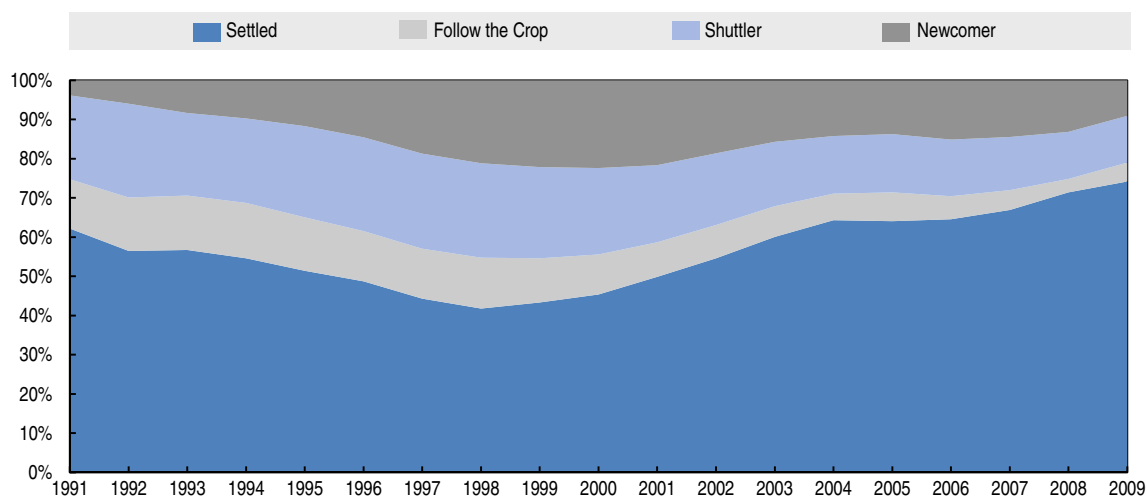
Figure 5.13. Number of years since foreign-born agricultural workers have migrated, 1999-2000 to 2009-10



Source: US Department of Labor (2015), National Agricultural Workers Survey, 2005-09, www.doleta.gov/agworker/naws.cfm.

StatLink  <http://dx.doi.org/10.1787/888933408656>

Figure 5.14. Migration patterns for hired US crop workers, 1991-2009



The figure shows three-year moving averages, e.g. 1991=1990-92 average.

Source: US Department of Labor, National Agricultural Workers Survey. www.doleta.gov/agworker/naws.cfm.

StatLink  <http://dx.doi.org/10.1787/888933408662>

The H-2A non-immigrant programme is designed to provide US farms with short-term agricultural labour when the number of available domestic workers is insufficient. H-2A labour certification is generally granted for activities lasting 10 months or less. Employers must perform recruitment activities to establish that US workers are not available, and successful applicants must pay transportation and housing costs for their workers, and abide by a regionally-specified minimum hourly wage rate.

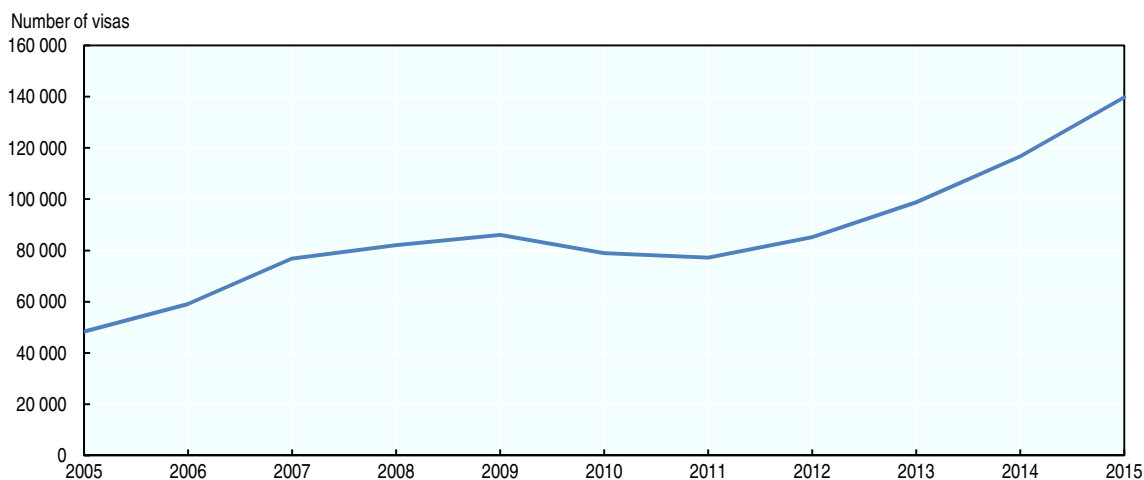
There is no yearly limit on the number of foreign workers who may be issued an H-2A visa, and their numbers have increased rapidly in the past five years, reaching 140 000 in 2015 (Figure 5.15). This figure represented 96% of positions requested, and 97% of complete applications were resolved in a timely fashion (more than 30 days before the date workers were needed).

Further proposed (but as yet not enacted) policies to grant legal status to significant numbers of currently unauthorised immigrants could increase their mobility in the US labour market, possibly encouraging unauthorised workers in agriculture to seek employment in other industries.

The Federal Government, through the US Department of Labor, also seeks to support farm workers and facilitate the operation of labour markets through the National Farmworker Jobs Program (NFJP), a nationally-directed, locally-administered programme for migrant and seasonal farm workers (MSFWs). The programme seeks to counter the chronic unemployment and underemployment experienced by MSFWs in the United States and Puerto Rico. It provides skills training, career counselling and assistance with job search. It also offers a range of support services designed to help farm workers and their families retain or stabilise their agricultural employment, or to participate in NFJP employment or training programmes, including direct assistance to help cover housing, transportation, nutrition, and child care costs.

In programme year 2012, more than 20 000 farm workers participated in NFJP; 86% entered employment, with a retention rate of 83% and average earnings over six months of USD 10 533.

Figure 5.15. H-2A Temporary visas certified for agricultural work, 2005-15



Source: US Department of Labor (2015), *Employment and Training Administration, Office of Foreign Labor Certification*. www.foreignlaborcert.doleta.gov/pdf/H-2A_Selected_Statistics_FY_2015_Q4.pdf.

StatLink  <http://dx.doi.org/10.1787/888933408675>

Public support for research into labour saving mechanisation technologies

Mechanisation and the adoption of other labour-productivity-enhancing technologies has historically been the primary way in which agricultural employers have responded to rising labour costs. Public support of fruit and vegetable mechanisation reached its peak in the 1960s and 1970s, when hired farm labour costs were rising rapidly.

Agricultural engineers in university and government research institutions worked with growers and private machinery manufacturers to develop labour aids to increase worker productivity and mechanical harvesters to reduce labour requirements. Efforts to mechanise fruit and vegetable production stalled after 1980 because there was a large supply of labour available, which held down wages. In addition, the substantial, federal- and state-supported mechanical research system for fresh fruit and vegetables was mostly dismantled during the 1980s, leaving such research primarily to the private sector.

Now there is renewed interest in agricultural mechanisation associated with the loss, or potential loss, of unauthorised foreign workers. A recent ERS report, based on case studies of apples, oranges, strawberries, raisins, asparagus, and lettuce, found a range of potential adjustments in the face of rising costs and reduced availability of hired labour (Calvin and Martin, 2010). Some crops had already partially adopted mechanical harvesters, and adoption would likely spread. Some un-mechanised crops with substantial import competition would likely lose production and market share, while others would look to either mechanise or to introduce labour aids to improve worker efficiency.

The Food, Conservation, and Energy Act of 2008 created the USDA Specialty Crop Research Initiative (SCRI), providing USD 230 million for fiscal years 2009-12 to support research on five issues critical to the future of the US fruit and vegetable industry, including “improved mechanisation.” This is the first major federal investment in mechanisation research for fruit and vegetables since the early 1980s. Research funded under this initiative requires non-federal matching funds equal to the federal expenditure.

Regulating the terms and conditions of agricultural employment

There are a set of labour-market policies that are applied broadly across the economy; however, agriculture is exempt from some, and some types of farms are exempt from others, so these form an agriculture-specific policy.

For example, the Fair Labor Standards Act (FLSA) is the primary federal legislation governing minimum wage and overtime pay requirements in the US. Agricultural employers are exempt from the overtime requirement, and hence do not have to pay time-and-one-half wage rates for hours worked in excess of 40 per week. Most farm workers are covered by federal minimum wage provisions, except for those employed on smaller farms (defined with regard to the amount of labour utilised in the preceding calendar year)

Also exempt are agricultural employees who are immediate family members of their employer; those principally engaged on the range in the production of livestock; and local hand harvest labourers who commute daily from their permanent residence, are paid on a piece rate basis in traditionally piece-rated occupations, and were engaged in agriculture less than thirteen weeks during the preceding calendar year. Twenty nine states and the District of Columbia have set minimum wage requirements that are above the federal minimum, but many of these states also make exceptions for some agricultural workers.

Agriculture consistently ranks as one of the most hazardous occupations (Table 5.3). Occupational injury and fatality rates substantially exceed those found in construction, mining, and manufacturing as well as other major sectors of the economy. Fatality rates in logging exceed those in crop and animal production, which in turn are higher than in other sectors. Advocates argue that federal workplace safety protections are inadequate: A minority of States, including California and Washington, provide additional safeguards for farm workers. A small fraction of workers (about 2%) benefit from union collective bargaining agreements which require additional safety measures.

Table 5.3. Occupational injuries and fatalities, by industry, 2014

Selected US Industries	Injuries and illnesses per 100 workers	Fatalities per 100 000 FTE workers
All private industry	3.2	3.6
Crop production	5.5	22.2
Animal production	7.1	18.1
Forestry and logging	5.1	96.7
Mining	2.8	15.8
Construction	3.6	13.6
Manufacturing	4.0	2.2
Animal slaughter	7.6	3.8
Automobile manufacturing	7.1	1.3
Wholesale trade	2.9	4.8
Retail trade	3.6	1.8
Transportation	4.8	13.5
Professional and business services	1.2	2.6

FTE: Full-time equivalent.

Source: US Bureau of Labor Statistics (2015). www.bls.gov.

Workers' compensation benefits are secured by insurance policies, paid for by the employer. Each state has its own standards and rules. When a covered worker suffers a job-related injury or illness, he/she can receive medical benefits and/or a portion of her lost wages, if he/she files a workers' compensation claim and that claim is approved. However, many States do not require all farm employers to provide workers' compensation insurance to migrant and seasonal farm workers.

Employers who hire legal temporary foreign workers under the H-2A visa programme are required to provide workers' compensation insurance or equivalent benefits to their employees. Thirteen states, the District of Columbia, Puerto Rico, and the Virgin Islands require employers to cover all seasonal agricultural workers to the same extent as all other workers. Thirteen additional states require large farmers to provide workmen's compensation coverage for their migrant and seasonal farm workers. By contrast, sixteen states do not require employers to provide any coverage for migrant or seasonal farm workers.

Pesticides pose risks of short- and long- term illness to farm workers and their families. The exact number of workers injured each year by pesticides is unknown, because there is no national surveillance system for acute pesticide illness reporting and no surveillance system for tracking chronic illness related to pesticide exposure. Thirty states require health professionals to report suspected pesticide poisoning, but many incidents go unreported due to a number of factors, including workers' failure to seek medical care, workers seeking medical care in Mexico, medical misdiagnosis, and health provider failure to report. Factors deterring farm workers and their families from seeking medical care for pesticide illness include lack of health insurance, language barriers, immigration status, cultural factors, lack of transportation, lack of awareness of or exclusion from workers' compensation benefits, and fear of job loss.

Education and skills policy

Education policy affects innovation in at least three ways: a high level of general and scientific education facilitates acceptance of technological innovation by society at large; innovation systems require well-educated researchers, teachers, extension officers, and producers to develop relevant innovations; it is generally easier for farmers and business operators with higher education and skills to adopt some technological innovations. Continuous skills development (training, re-training) is essential to improve the matching of skills demand in an evolving agri-food sector, which needs to adopt productivity- and environmentally-enhancing technologies and practices.

Many studies investigated the link between education and technology adoption, which leads to productivity growth. Reviewing available literature, Huffman (2001) found that US farmers with higher levels of education appear to be more likely to adopt new and technologically sophisticated innovation. For example, they were more likely to adopt computer technologies, and to adopt certain new inputs in cattle feeding in the 1980s. More recently, Khanal, Gillespie and MacDonald (2010) found that dairy farmers with a college degree were more likely to adopt computerised feeding systems and new breeding technologies such as embryo transfer. Fernandez-Cornejo and McBride (2002) found that maize growers with a college degree were more likely to adopt genetically engineered insect-resistant or herbicide-tolerant seeds in the early years of commercial availability of such seeds. Schimmelpfennig and Ebel (2016) found that maize farmers with at least some college education are more likely to adopt precision agriculture technologies such as yield monitors, variable rate spraying, and automatic guidance systems.

Other studies estimated directly the link between education and total factor productivity (TFP). For example, in an analysis of a panel of US states covering 1950-1982, Huffman and Evenson (1993) found that the average years of education of the farm population had a large, positive, and statistically significant impact on state-level TFP. This study extends early work by Griliches (1963), who found that an index of the education of farm labour was positively associated with increased farm output, while controlling for other farm inputs in a model of agricultural production.⁴

Government plays a primary role in financing and managing education, both in general and specifically for agriculture, where the land-grant system of universities has played a major role in encouraging agricultural research, education, and extension.

State and local government have primary responsibility for administering and funding educational institutions. States set overall policies and standards for elementary and secondary institutions located; local governments administer public elementary and secondary schools; and local and state governments combine to provide most funding for public elementary and secondary schools. State governments also provide support for public post-secondary institutions, although the amount of support varies widely across states.

Overall achievement

The US education and training system is considered by the business community as one of the top five performers in the OECD area, together with Finland, the Netherlands and Switzerland (Figure 5.16). It is ranked particularly high for secondary and tertiary education enrolment rates (quantity of education, see details below). A large proportion of adults have reached tertiary education (44% compared to 33% on average across OECD countries) and the government aims to reach 60% by 2020 (OECD, 2015a). While the United States is not as highly considered for the quality of the education provided as measured by the ability to meet labour market needs, they still rank slightly above the OECD average and in recent years, unemployment rates have been below the OECD average for all levels of education.

Tertiary education offers a particularly high pay-off, and US workers with below secondary education face large earnings disadvantages throughout their working life (OECD, 2015a). The gender gap in favour of men is one of the largest in OECD countries in terms of earnings. Part of the difference can be explained by the lower share of women in high earning activities such as engineering and computer sciences.

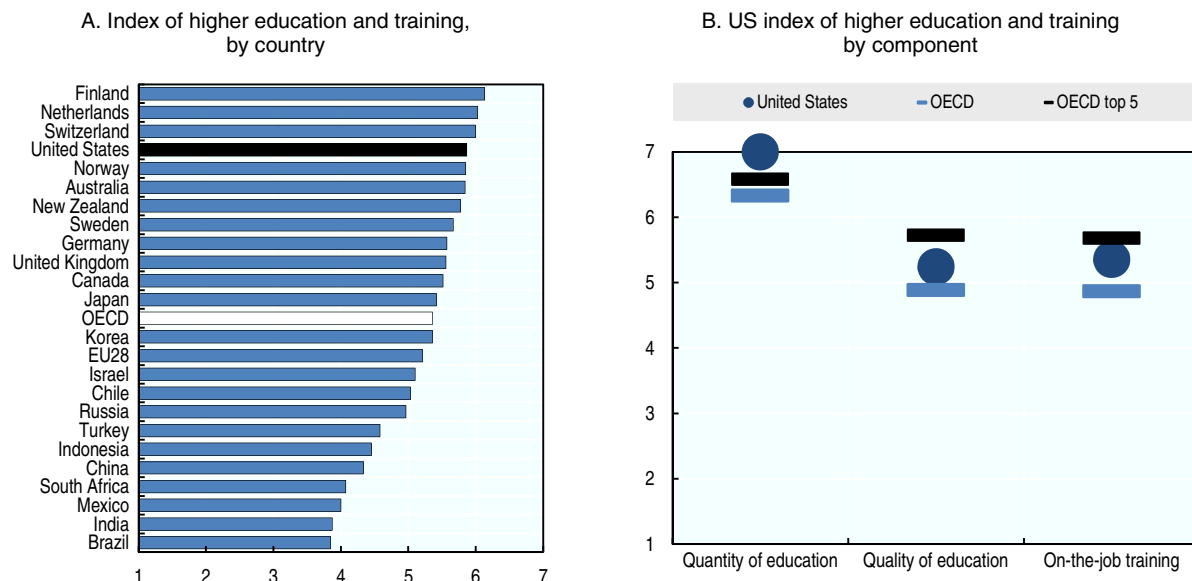
In 2013, a lower percentage of students graduated from science and engineering programmes than on average across OECD countries (15% compared to 23% from tertiary programmes; 17% compared to 22% from Bachelor's programmes). Moreover, there has been a relative decline on doctoral graduates in science and engineering (OECD, 2014).

The United States is the global leader in tertiary education: it attracted alone close to one fifth of all foreign students in 2012, but they account for a small percentage of all students engaged in tertiary programmes.

Despite the relatively high level of education, low “basic” skills are more common in the United States than on average across OECD countries. One in six adults has low literacy skills and nearly one in three has weak numeracy skills against an OECD average of one in five. In terms of “problem solving in technology-rich environments” the US results are a little worse than the OECD average. Explanations for the relatively weak performance of the United States include failings in initial schooling, lack of improvement in educational attainment over time, and poor skills in some subpopulations including migrants. Moreover, there are few signs of improvement as the average basic skills of young adults are not very different from older persons (OECD, 2013a and b).

Figure 5.16. Global Competitiveness Index: Higher Education and Training, 2015-16

Scale 1 to 7 (best)



Indices for EU28 and OECD are the simple average of member-country indices.

Data for the Quantity of education index comes from UNESCO Institute for Statistics.

OECD top 5 refers to the average of the scores for the top 5 performers among OECD countries (Finland, Netherlands, Switzerland, Belgium and United States).

The quantity of education index is based on secondary and tertiary education enrolment rates from UNESCO Institute for Statistics. The quality of education index is based on responses from a WEF Executive Opinion Survey on “How well does the educational system meet the needs of a competitive economy; Executives’ assessment of the quality of math and science education in schools and the quality of business schools; and on how widespread is Internet access in schools. The on-the-job-training index is based on survey responses on the availability of high-quality, specialised training services and the extent to which companies invest in training and employee development.

Source: World Economic Forum (2015), *The Global Competitiveness Report 2015-2016: Full data Edition*, Geneva 2015. www.weforum.org/reports/global-competitiveness-report-2015.

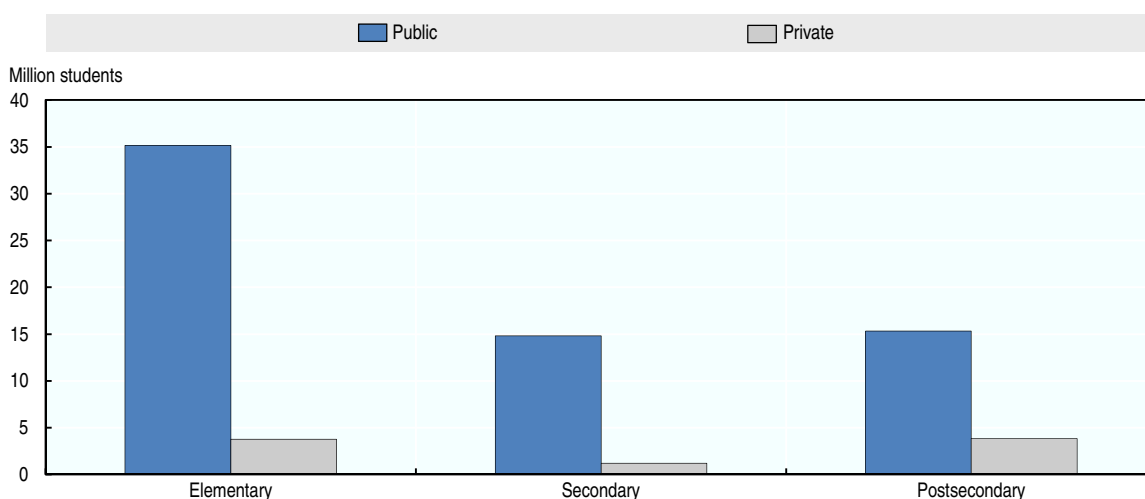
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The performance of the initial schooling system is closely linked to adult skills and the US results from the international PISA assessment of the basic skills of 15-year-olds are consistent with the results for adults. According to the 2012 PISA survey, 15-year old US students perform below average in mathematics and the country ranks in the bottom half of OECD countries, and one in four does not reach proficiency levels, a higher percentage than the OECD average. Performance in reading and science are both close to the OECD average. As for adults, the socio-economic background has a significant impact on student performance in the United States. Although this impact has weakened over time, disadvantaged students show less engagement, drive, motivation and self-beliefs (OECD, 2015b, 2016).

General education enrolment, attainment and funding

Public schools account for 90% of enrolment in elementary schools, and 93% of enrolment in secondary schools (Figure 5.17). Religious schools account for about 80% of private elementary and secondary school enrolment, with the remainder enrolled in non-sectarian private schools. In turn, Catholic schools account for half of enrolment at religious schools. In addition, 1.77 million children between the ages of 5 and 17 are home-schooled (about 5% of total enrolment in elementary and secondary schools). State governments set educational standards (such as minimum days and hours in class; textbook coverage; diploma requirements) for all education in the state, and some provide financial support for non-public education.

Figure 5.17. Enrolment in US educational institutions by level and control of institution, 2014

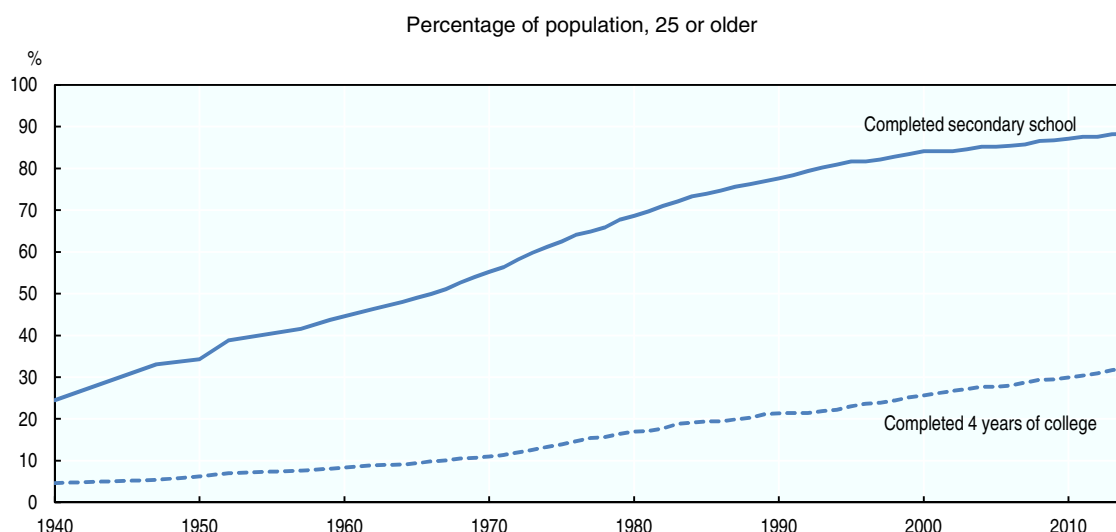


Source: US Department of Education (2015), *National Center for Education Statistics*, <http://nces.ed.gov/datatools/>.

StatLink  <http://dx.doi.org/10.1787/888933408695>

Postsecondary institutions include community colleges that provide associate degrees, usually requiring two years of full-time study; colleges and universities that provide bachelor degrees usually requiring four years of full-time study; and post-baccalaureate professional and graduate programmes usually located in universities. Private institutions account for about one-third of professional and graduate enrolments, one-fifth of enrolment in undergraduate four-year programmes; and less than one-tenth of enrolment in two-year associate degree programmes.

Increasing educational attainment has been one important force driving productivity growth in the US economy (Figure 5.18). By 2014, 88% of adults aged 25 and older had completed secondary education, as compared to 69% in 1980 and 25% in 1940; 32% had completed at least four years of college, compared to 17% in 1980 and 5% in 1940. However, there is concern that growth in educational attainment is slowing, and that slowing growth will constrain future economy-wide productivity growth.

Figure 5.18. Educational attainment in the United States, 1940-2013

Source: US Census Bureau (2015), Current Population Survey. www.census.gov/programs-surveys/cps.html.

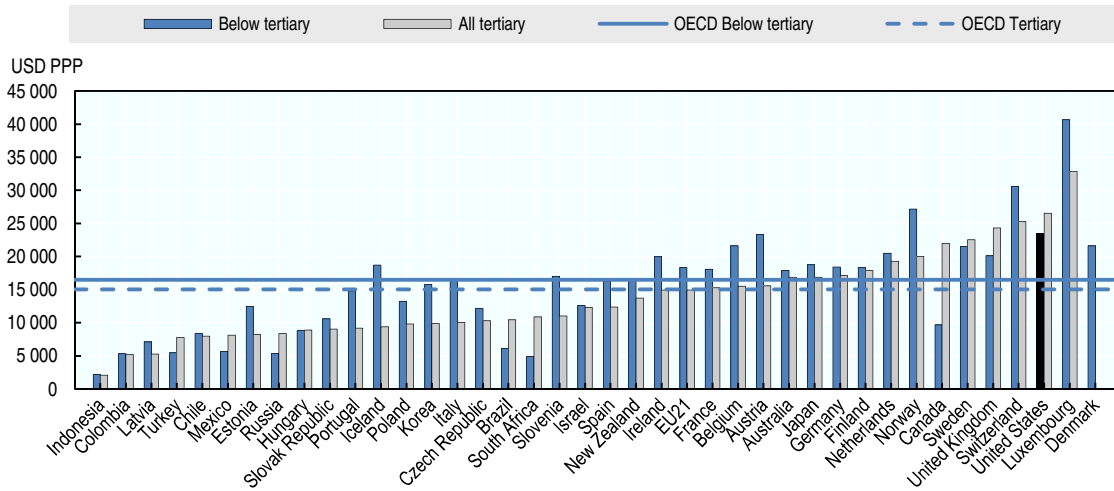
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US expenditures on secondary education are equivalent to expenditures in other high-income OECD countries. Per-student expenditures for post-secondary education exceed expenditures in other OECD countries, and substantially exceed most (Figure 5.19). They remained higher despite a decrease between 2008 and 2012, in particular for tertiary education (OECD, 2015a). Public and private expenditure on education expenditure remained higher than the OECD average (Figure 5.20).

Parts of those expenditures are financed through tuition fees, and the United States has the highest average tuition fees for public universities among OECD countries. While US universities also offer relief from tuition in the form of grants, loans, and scholarships, there is concern that rising tuition is deterring attendance and slowing growth in educational attainment.

In a report considering economic policy reforms supporting growth, OECD (2015c) finds that a more inclusive education system would foster gains in productivity and income. The report welcomes the new law that bases interest rates for student loans on long-term treasury bonds, and efforts to increase access to pre-school education, as an effective means to reduce future inequalities. Recommendations include expanding effective pre-schooling initiatives, ensuring states meet quality standards to receive federal support, including for teachers, and supporting the introduction of common core standards in primary and secondary schools.

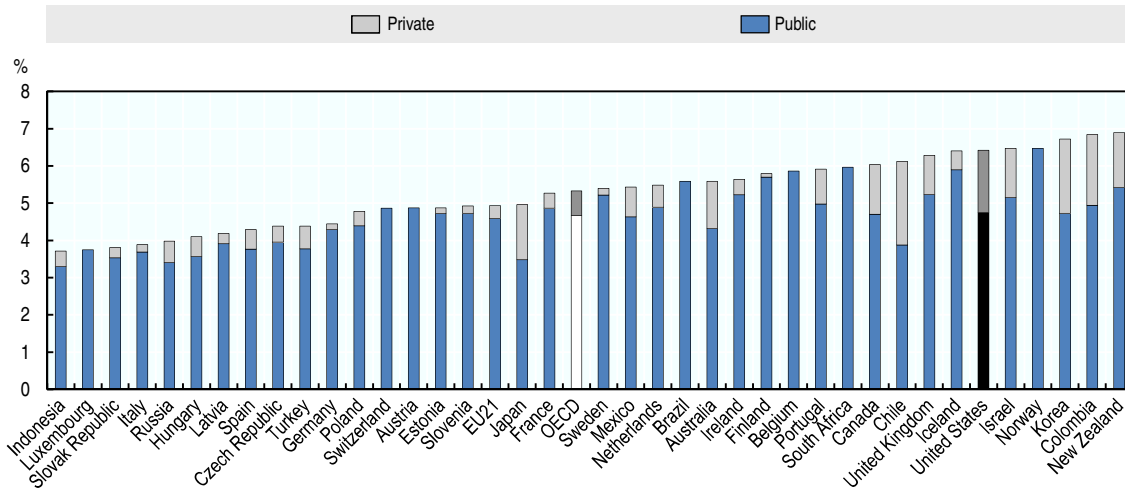
Figure 5.19. Average public expenditure per student by educational institutions, 2012



Source: OECD (2015a), *Education at a Glance 2015: OECD Indicators*, <http://dx.doi.org/10.1787/eag-2015-en>.

StatLink  <http://dx.doi.org/10.1787/888933408717>

Figure 5.20. Public and private expenditure on educational institutions as a percentage of GDP, 2012



Public expenditure includes public subsidies to households attributable for educational institutions, and direct expenditure on educational institutions from international sources. Private expenditure is net of public subsidies attributable for educational institutions.

Source: OECD (2015a), *Education at a Glance 2015: OECD Indicators*, <http://dx.doi.org/10.1787/eag-2015-en>.

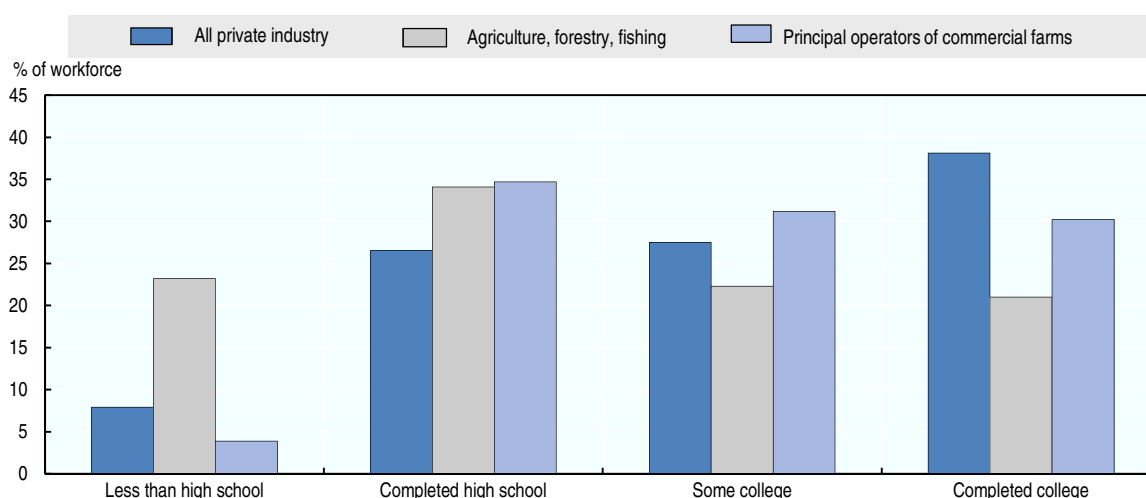
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Agricultural education

About 38% of employees in private industry in the United States have completed a four-year college programme (including employees who have gone on to complete professional or graduate degrees). Another 28% have completed some college training, while only 8% have not completed high school (Figure 5.21). This distribution stands in sharp contrast to the workforce in agriculture: nearly a quarter of those employed in agriculture have not completed high school, while just over 20% have a four-year college degree. Labourers, typically with limited years in school, make up a substantial share of the hired workforce in agriculture, and greatly outnumber hired managers.

Farm operators fall in between (Figure 5.21). Thirty percent of the principal operators of commercial farms (farms with at least USD 350 000 in sales) have a college degree, while another 31% have completed some college, frequently in two-year programmes focused on agricultural specialties.

Figure 5.21. Educational attainment by industry of employment, 2014



Source: USDA (2015), *Agricultural Resource Management Survey for principal operators of commercial farms; 2014 Current Population Survey for others (25 years and older)*. www.ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices/arms-data.aspx.

StatLink  <http://dx.doi.org/10.1787/888933408732>

The United States makes a significant investment in education for agriculture. The formal training of the next generation of farm operators begins in secondary schools where about 12 000 agricultural educators provide instruction in over 8 000 school-based programmes, to about 1 million students enrolled in food and agricultural education courses. Agricultural education in secondary schools combines classroom and laboratory instruction with experiential learning outside the classroom and leadership programmes delivered through organisations like 4-H and Future Farmers of America (FFA). Most formal food and agricultural education programmes are found in small towns and rural areas across the country. There are numerous and diverse programmes, but limited coordination in terms of design, implementation and monitoring (Mercier, 2015).

The United States has an extensive post-secondary programme of agricultural research and education, operated primarily through its system of land-grant institutions, a set of organisational innovations developed and extended in the 19th and 20th centuries. The Morrill Act of 1862 granted federally controlled land to the states for them to sell to raise funds to establish and endow colleges that would focus on the teaching of agriculture and the mechanical arts (though “without excluding classical studies”). A second Morrill Act, in 1890, aimed at the former Confederate states in the South. It provided cash instead of land, and required each state to show that race was not an admissions criterion, or to designate a separate land-grant institution for persons of colour.

In 1887, the Federal Hatch Act provided federal funding to establish a State Agricultural Experiment Station in each state for the purpose of agricultural research. Then, in 1914, Congress passed the Smith-Lever Act to create cooperative state extension services, intended to disseminate knowledge generated at colleges of agriculture to farms and consumers. The extension services are cooperative ventures of state and federal governments, and draw funding from each; county governments, through networks of county extension agents, are also cooperative extension partners.

The three legs of the institutional structure — research, education, and extension — were combined in colleges of agriculture in the land-grant institutions. The colleges of agriculture were augmented by colleges of veterinary medicine — 25 of the 27 in the country are located at land-grant universities. Some faculties at veterinary colleges have appointments in agricultural experiment stations, and veterinary colleges may also participate in cooperative extension programmes. Most states also established systems of public two-year community colleges and four-year state college systems; some of those colleges provide educational and extension programmes in agriculture and environmental and food sciences. While some will take jobs in farming, others will work in agricultural services, agri-food firms, government, and academia.

The land-grant universities and other institutions are expected to graduate an estimated 35 000 people annually between 2015 and 2020 with degrees in agriculture, renewable natural resources, or the environment. This number represents 61% of the projected 58 000 average annual openings for graduates with bachelor's or higher degrees in those areas. US universities award about 1 200 doctoral degrees in agricultural sciences each year, with a growing share being awarded in natural resources (including forestry, fisheries and wildlife) (Chapter 7). Scholarships for agriculture majors are sponsored by a variety of sources, including federal and state governments, professional associations, and colleges and universities.

Public extension programmes face increasing competition from private sector firms, as farmers obtain advice and technical guidance from independent crop consultants and custom service providers, veterinarians who also provide guidance on feed formulations and livestock marketing, technical specialists working for input suppliers, and lenders. Private sector advisors typically obtained their training at land-grant universities and associated institutions.

In addition to providing credit support (as described in Chapter 4), USDA also sponsors training programmes for new entrants into agriculture. The Beginning Farmer and Rancher Development Program (BFRDP), awards grants to organisations, including cooperative extension services, land-grant institutions, and others, who support beginning farmers and ranchers through workshops, educational teams, training, and technical assistance. Special emphasis is placed on women farmers, youth, veterans, current farm workers, and members of socially-disadvantaged and limited-resource communities, including international refugees.

More than 38 000 new and potential farmers participated in BFRDP project training events in programme year 2011. Of these 30% had little or no experience in agriculture, while less than one percent were current hired farm workers; 17% were women; and 16% were from socially disadvantaged groups. Forty-five percent of participants surveyed planned to start a farm after the training.

In the United States as in other countries, agricultural education systems face a number of challenges. Knowledge needed to improve agricultural productivity and sustainability include a broader range of topics, and a challenge is to move beyond production agriculture towards food and nutrition, natural resources and general knowledge such as ICT, business management and other socio-economic issues. There is a wide range of courses covering all these areas in the United States, but curricula are often highly specialised in science fields, in particular at tertiary level, and leave little flexibility to acquire additional knowledge that is increasingly important in research (e.g. ethics, economics) (Ciheam, 2015). Another challenge is to attract students in areas where jobs will be created. USDA projections indicate that there would be a 41% shortfall of US college graduates in food, renewable energy and environmental specialities compared to job openings over the period 2015-20 (Goecker

et al., 2015). US higher agricultural education is extremely successful in attracting foreign students, which account for about 40% of doctoral degrees in agricultural sciences (Chapter 7). Finally, education is expected to contribute to improving understanding of agriculture and food in the general public (Mercier, 2015).

Summary

- Well-developed transport infrastructure facilitates the movement of agro-food products and farm inputs within the country and to points of export. Responsibilities for funding and operating infrastructure vary by means of transport. Most highway and waterway investment is publically funded, while freight railways are privately funded and maintained. Resources for road infrastructure originated mainly from a tax on gas, but are now more diversified. Train freight has become more concentrated and the issue of rail competition remains an important one for agricultural shippers, in particular when waterways are not an option.
- While access to infrastructure and services is unequal across regions (better in densely populated areas of the North-East), this is weighted against other considerations and does not prevent economic activity in areas with lower coverage.
- The quality of ICT infrastructure ranks slightly above the OECD average, but the number of mobile telephone subscriptions per capita is below average and fixed broadband access is unequal across the country. However, high speed Long-Term Evolution mobile telephony is particularly well-developed and covers over 95% of the continental territory. While Internet development has been mainly privately funded, recent federal programmes aim to enhance household Internet participation.
- Electricity transmission is organised into five networks which cannot be easily interconnected. Some deregulation of electricity generation and distribution started in the 1970s, but deregulation has slowed down as issues regarding competition emerged. Other changes include the diversification of energy supply away from coal as a fuel source towards natural gas (from fracking) and wind power. This diversification has benefited some farmers, which receive income from energy leases (natural gas, oil or wind). A number of large livestock farms also produce energy from anaerobic digesters.
- USDA is the lead federal agency for rural development programmes providing loans, grants and technical assistance to support development of rural companies, utility infrastructure and housing and community facilities. Over the years the share of assistance provided by USDA rural development programmes under grant and direct loan programmes has declined, while guaranteed loans have increased in importance. Other federal agencies such as the Department of Transportation or the Small Business Administration also provide assistance to rural communities. State and local governments also influence rural development through programmes, investments and tax incentives.
- The United States has one of most efficient labour market among G20 countries, and the least restrictive employment protection legislation, in particular for temporary forms of employment. Agriculture is exempted from some rules (overtime pay, minimum salaries in small farms, part-time farm household members, safety protection).
- The high US capacity to attract and retain talent is particularly important for agricultural innovation as the US innovation system attracts well-qualified nationals and foreigners.

- Agricultural employment has been steady for the last decade, and covers a diversity of full-time and part-time farm household members, as well as hired labour.
- Immigration policy matters for agriculture, which hires many farm workers born outside the country, in particular in the fruit and vegetable sector. New immigration laws, more vigorous enforcement of immigration laws, and changes in the incentives to migrate from Mexico have slowed immigration so that the hired farm workforce has become older and more settled. Specific visas are being issued to fill seasonal needs. A federal programme provides skills training, assistance to job search and other services to immigrant farm workers in order to reduce unemployment and stabilise their agricultural employment (with a good success rate as measured by the percentage of persons which have entered and kept employment).
- Labour saving mechanisation technologies provide a response to higher farm labour costs, and have contributed to TFP growth. In some sectors, they also have also permitted higher engagement of farm operators into off-farm activities. There is renewed interest for these technologies to respond to foreign labour shortage.
- The US education and training system is a top OECD performer for its high secondary and tertiary education enrolment rates, but less so for the ability to meet labour market needs, although unemployment levels are relatively low in the country. Tertiary education offers a particularly high pay-off.
- A lower percentage of students graduated from science and engineering programmes than on average across OECD countries. The gender gap in favour of men can be partly explained by the lower share of women in high earning activities such as engineering and computer sciences.
- The United States is a global leader in tertiary education, which attracts a high number of foreign students, including in agriculture.
- State and local governments have primary responsibility for administering and funding educational institutions with state governments setting educational standards. Most elementary and secondary schools are public, but private institutions account for about one third of professional and graduate enrolment. The US population reached high rates of enrolment and education attainment earlier than in other OECD countries, and the country spends more per student than most countries but the performance in terms of achievements and skills are below the OECD average.
- The United States makes a significant investment in education for agriculture. Agricultural education starts in secondary schools and combines classroom and laboratory instruction with experiential learning. An extensive post-secondary programme of agricultural research and education is operated primarily through its system of land-grant institutions, which combines research, education and extension activities.
- There are numerous programmes to provide education and training in agriculture and food-related areas, covering a large breadth of topics. Government support for training of entrants into agriculture focuses on women, youth, veterans, current farm workers and socially disadvantaged populations.

Notes

1. In each infrastructure component, the top five OECD countries are mostly smaller European countries with denser networks.
2. All years referred to in this chapter are fiscal years (FY).
3. Funding for these programmes is provided from electric cooperative investments and fees.
4. Griliches' findings influenced later work on the measurement of agricultural productivity; for example, the USDA productivity accounts include a quality-adjusted labour input, wherein hours of labour are adjusted for the education and experience profile of the farm labour force. The adjustment reflects the earnings advantages accruing to higher levels of education and experience in the US labour market.

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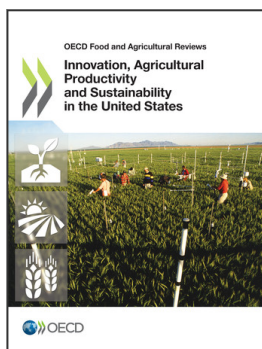
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