MINUTES OF THE MEETING
FINANCE AND CLAIMS COMMITTEE
MONTANA STATE SENATE

April 11, 1981

The forty-second meeting of the Senate Finance and Claims Committee met on the above date in room 108 of the State Capitol Building with Senator Himsl, Chairman calling the meeting to order at 8:11 a.m. Roll Call was taken and all were present except Senator Thomas.

CONSIDERATION OF HOUSE BILL 854: Representative Ernst, District 47 and chief sponsor of House Bill 854 said this is an act to appropriate money to the Dept. of Commerce to plan and coordinate transportation and pursue analysis and litigation. When the Governor gave us his state of the state message he promised a transportation plan. Subsequent to that we looked at it and wanted the Agriculture Division with this. This would be more coordination and would help divert against some increases. People now have to prove their cost and bring their case to the ICC.

Gordon McOmber, Director of the Department of Agriculture said they support H. B. 854. This is based on forming a consolidated, effective and probably further effort on transportation. Montana produces a lot of products and our economy depends on reasonable costs to transport the products. We have done a lot but do not have the money to do a good job. There is no legal authority from PSC to do the job on interest rates. Last fall the Staggers deregulation law was passed. More latitude to the railroads to fix rates and abandon lines. In some states it works where there is competition. In Montana with one railroad left we do not have an effective regulation bureau to take care of the problems in Montana. We used to think of freight rates as mostly problems of farmers, but many businesses are also having the freight problems. The President of the Pacific Iron Company in Great Falls says they are facing rate increases of over 50%. We have copies of these letters we will hand out. North Dakota has just become aware the Burlington Northern will abandon 2200 miles of line.

Keith Kelly, Governor's office said the House did reduce the bill so that it is about 50% lower than the governor recommendation. He passed out a sheet for the committee's information. House Bill 500 is already in, they are well on in progress. This proposal would add in 5 FTE. The additional funding is being asked by the Legislature. He explained the chart with the color codes on the back sheet, and how they worked together.

Mr. John Craig, an engineer of the rail planning unit for the Department of Highways. The House has modified the bill to eliminate an Inspector and Draftsman. This leaves 3 1/2 FTE.

This would be 1/2 FTE above and beyond. He went through the chart to show where they fit into the unified plan. Their part is represented by the "D" in the chart.

Byron Roberts was unable to make it this morning. The part represented by the "C" in the chart is the Department of Community Affairs now and are being moved in mass as C 2, C 3, and C 4 and will come through the appropriation process and are in H.B. 500.

Byron Roberts then showed up and said their function is being moved in mass and their functions are basically not changing. These are federal funds. We have a state wide planning system and design systems in some of the cities. They have done special studies for assistance for the elderly and handicapped, and this also contains funds for the administration of the program. We currently have 60 vehicles in different areas of Montana. We provide capital operating subsidy, and most of the major cities are subsidized.

Terry Whiteside, Transportation and Marketing Unit, Department of Agriculture, said the B 3 on the chart was eliminated by the House, combining B5 and B6 into one position. That left effectivel 5 positions. Currently we have 3 FTE. The functions will be to provide the economic analysis to produce effective litigation and services to other shippers. The shippers are not able to finan the burden of process under the Market Dominence Provision of the Staggers Land Act Provision. He explained the chart, how they would be coordinated and what they would be doing.

Mons Teigen, Montana Stock Growers, Cow Belles and Woolgrowers Associations, said they were concerned with the inadequate funding. We also perceived that transportation (rail) was primarily a problem of the rural people and the grain farmers. We thought in order for the money spent in McOmbers office to be handled properly it should be in the Department of Commerce. Logically, Mr. McOmber was not that enthused. We have met with the Governor. At the start the Governor was not to excited about the idea. We pointed our some of the problems facing agriculture in the next few years. Agriculture is part of the economy of the state and should be in there. With the additional funding proposed under 854 included in the newly organized Department of Commerce we may be moving on their way in the transportation industry. When livestock were flagged out of B. N. no one was aware of what had happened until it was all over. Rail transportation is important to the state. It is important that we pass this bill as funded. This is bare bones.

Viggo Anderson, Montana Citizens Freight Rate Association, said transportation is as important as any subject the Legislature will address this session. In this case we have a case where the economy of the state is dependent on a single monoply rail system. They are there to make money, and will pass rates on

whatever the traffic will bear, and in this case a monopoly and the traffic will bear quite a load. The Staggers Act is a new ball game. This bill is a step in the right direction.

Jim Christianson, Wheat Commission in Great Falls said we have been moved out of the west coast marketing. I have been told they can get their grain cheaper from Nebraska and that area because of the differential in the freight rates. Glendive is 200 miles closer than North Platt, Nebraska, but it is higher. He gave the comparison figures. Freight is so high and 90% of the wheat in Montana moves simply because of freight rates. It is extremely important to support this bill.

Bob Stevens, Montana Grain Growers Association said the future of the grain growers rests with the office of the B. N. and service depends on what the B. N. does on transportation. When trucks come into competition they cut rates just enough to put them out of business and then raise the prices again. If the current class action suit is any criteria it will be study costs of $130,000 or more. Our main concern is that it might not be enough. Grain growers put $150,000 a year in the Department of Agriculture that will be transferred to the Department of Commerce. There was concern that shifting to the department of Commerce would possibly downgrade the grain growers. However, it is not funded now by Agriculture and has a broader support.

Joe Brand, testifying as a former employee of the Milwaukee Railroad and a stockholder of the railroad. I realize the problems have been in higher offices than in Montana. Montana, for the last 25 years has watched the downfall of the transportation industry. We say we want to entice business to Montana. The thing you have to have is a viable transportation industry. You cannot attract industry if there is no way to take the products out or if the rate is too high. This attempt to form a department to look into the shipping and the receiving of goods into this state is good. Before the burden of proof was on the railroads, and then the Staggers act came into place. Under the 4 R act under some circumstances they did not come under federal help. What happened was the weaker railroads went to bankruptcy moved. In the merger, the Milwaukee was not included. They have them a few concessions most of which they could not use. The holding companies are monsters created by the railroads. They take the assets of the railroad and put it into other things, such as a can company, asphalt company, etc. and were more interested in those companies to make money than in the railroad and as a result do not care what happens to them The officers in the end, on the Milwaukee, were on the B. N. railroad. Even the traffic person, who is supposed to go out and get business came from the B. N. The B. N. is in the process of starting a holding company. We need a viable transportation system; highway, railroad, air, all must be coordinated otherwise Montana is not in business.

Ken Clark, United Transportation Union, said the cost of care loading--there is no contract with the railroads. 125 miles may be 10 hours the railroad doesn't care. The ICC has seen fit to say you can allow this much for an outfit.and it is through the ICC rulling that they are able to do it. The railroads use this to say the conductor did not pick up this car. The conductor does what the dispatcher says.

Jo Brunner said she was speaking for Women in Farm Economics, Montana Farmers Union, Montana Cattle Feeders and ASARCO. She said these organizationa all support the bill. Statement attached.

Gary Buchanan, Acting Director of the Department of Commerce said they support the 432 created by the Department of Commerce, and it has been signed into law. An attempt to consolidate the transportation in Montana is badly needed. The support for the Transportation effort came later and was not put under the original proposal to expand the level of effort. I support it. I feel with the services from 2 more departments together that we can administer the program and I would express support.

There were no further proponents, and the Chairman asked if there were opponents.

Representative Cozzens, H.B. 64 said he was a pseudo opponent. I am not against the concept. I served on the subcommittee with Senator Smith and Stimatz. I asked the question why there were 3 Departments of Transportation. We had much to gain by consolidating and I was delighted to hear it was the wish of the Governor. I had some questions as to the level of expenditures being asked for in the testimony given on the House side. When I asked how much further, (testimony attached), I asked for additional information. They gave more money than we were under the assumption there was in the House. I endorse the concept and putting it under one house. This was the first we heard much about the Staggers Act. We scheduled a hearing. I had an evening meeting in January or February and it is still an area where there are more questions than answers available. It was put into effect in October of last year. The impact is being felt in Montana. There is a suit in Great Falls questioning the constitutionality of it. If that doesn't happen, we have increased this budget for more FTE and more money based on the outcome. He quoted the duties of the Consumer Council and asked why they are not functioning on this. He also felt we were being a bit premature in sponsoring an advisory council as well as the Governor asking for a special transportation committee being formed in the interim. He also referred to the handouts that Mr. Kelly had given. He said 4 out of 5 are all executive positions. Under the existing Department of 10 people we adding 5, 4 of which are significant salaried employees to the state government.

Ralph Avery, specialist from B. N. said he was not really an opponent to the bill. He said Mr. Cozzens had asked if I could come up here and clear up some myths about the Staggers Act. I am not opposing the Department of Transportation, we feel the Governor should be commended for bringing this under one roof. Some people have a habit of reporting without doing a lot of work toward the truth. Mr. Templeton had been at the case. The issue was service and a couple of people thought they had not been treated right. In the case they ruled that there is a class of people that have a right to sue the railroads. There was nothing decided about the discretionary rates. The Staggers Act does not change the boundry lines. They have set down a stricter time table. So it won't sit on a shelf and rot. Someone here said that North Dakota was made aware B. N. was to abandon 2200 miles of railroad. We don't have that many miles of railroad in North Dakota. The President said in North Dakota and Montana we will not abandon any railroad. We will retire some properties when proved unprofitable and can be proven to be so. I have appeared on numerous cases before the PSC. Yet we are told the PSC does not have that authority. There is nothing in the act that shifts the burden of proof. He explained the process and findings. He said the burden of proof was on the shipper to show it was irreparable. Nothing is shifted here and since you do not have to prove anything therefore it does not justify the funding.

Representative Stobie spoke as an opponent of the bill. He said the point he wanted to bring out is the fact that -- or I believe, that when someone adds a rate regulation it is all on one side. The question is one to share. It can create work for the private sector. The costs born by the work created must be born by the shipper. In my simple life as a merchant and family man, I can see that every time there is a added government employee then I somehow have to pay for it and the consumer. I wonder if that won't happen to the railroads and the shipper in this case. I would hope you could take a close look at the amendments.

Questions from the committee:

Senator Himsl: Mons Teigen, had to catch a plane, but he said something about the cattle industry being flagged out of B. N. McOmber: Cattle cars are no longer available.

Senator Himsl: Was this proposal presented to the subcommittee. Is this something that came up afterward? Buchanan: When he presented the Dept. of Commerce to the subcommittee this was not being actively considered by the Agriculture people. It was not part of my proposals. This is an additional bill that came up and is an addition.

Senator Himsl: The concept to have it in one place was not in? Buchanan: The railroad planning had moved to put them into land a planning division.

Representative Cozzens: I had actually contributed to this but did not feel they would need further funds since the three individual units were fully funded.

Terry Whiteside: No, not completely funded. McOmber: We had requested 50 or 60,000 to fund it. It was taken out by the fiscal analyst.

Mr. Buchanan: Agriculture department was not a part of the Department of Commerce.

Senator Story: You transferred the present operation from Agriculture to Commerce? Cozzens: This bill does consolidate the three.

Senator Story: Is Agriculture reduced by that much? Cozzens: It is my understanding those funds would go over. Story: Not an increase? Cozzens: They are already funded about $1 million. This bill is actually for additional money.

Senator Smith: We have a Marketing and Transportation of $100,000 for wheat check-off money and many of the farmers also gave some support assistance. The $9 million is for land construction--not administration. That is an 80-20 federal railroad match.

Senator Regan: If you will take a second look on the second sheet it was an 11.8% decrease. You are looking at a decrease not an increase over the next biennium.

Senator Dover: What Senator Regan said is true. The main reason is the decreased assistance of federal funds in the old ones that are not included in this budget.

Senator Keating: I would like to ask the railroad. One of the things that seem to require this addition is a cent or two difference in rate of hauling wheat so many miles. Why the difference in the rate between Nebraska and Montana?

Mr. Avery: Kansas rates do not interest us. We do not publish them, or on the discount rates, they have not made the adjustments. One reason here is that the Union Pacific chose to reduce the rates to attract the business there. We had to meet the rate to participate. It is now an unsatisfactory contribution. We did not think it necessary and don't feel it necessary to the railroad than in December 1980.

Senator Keating: B.N. is really competing with Union Pacific to the West Coast? Avery: Right

Senator Keating: On the question of the West Coast. Could you make money and be profitable in handling wheat? Is hauling wheat a burden to you?

Mr. Avery: No. We feel it is a very welcome chore. We do want to haul it. Particularily Montana Wheat.

Mr. McOmber: I made a mistake and I would like to correct it. In my reference to B. N. abandoning lines in North Dakota. This came from an Old West Regional Report. B. N. says at least 1/3 should be abandoned in the miles.

Representative Ernst closed by saying that $200,000 by grain growers by solicited to make the court case. It was hard to be sure we could raise it. If the Staggers Act is declared unconstitutional, there will be a continuous fight because that is the history of it. We need people to defend us before the ICC.

Senator Himsl declared the hearing closed.

CONSIDERATION OF HOUSE BILL 469: Representative Thoft said this is a $50,000 appropriation to support the seed potatoe research at Montana State University. This is virus free seed stock for Montana. While the Agriculture Experiment was treated well, this is not theirs, it is a grower supported program. MSU takes an administrative piece of the top for the program. The contribute $40,000 for inspection, $150,000 for equipment and a building, green house, etc., at MSU for the research process. Basically the problem is that we are involved in a couple of law suits because of a virus.

Mike Kohnke, Seed potatoe grower from Townsend, said he would explain a little about the vegetative versus the biotonic process of reproduction. Potatoes are mostly reproduced through the vegetative process which in the case of potatoes is through planting a tuber or a part of a tuber. Under this project, $50,000 of renewable resource funds would go to this program to develop clean seed stock. You let the potatoe grow up and cut the potatoe and grow it in a test tube and you have disease free seed. We have been funding the program 100% by grower participation. We want to get into a project that is too expensive to do ourselves. Down in the basement of the greenhouse is our laboratory and we want to do Meristem testing. He explained this project as developing the foliar embryo in the "notch" between two leaves that can be developed, grown to tuber stage and then to propagate disease free tubors for seed and saving about 2 years time.

He said this would help the certified seed potatoe industry and the economy of Montana.

Mike Sun, Montana State University, a potatoe specialist engaged in the educational program. The seed potatoe industry is competing against the potatoe industry in other states. If they can get the help they will be in a good position to compete, if they don't they will have to have time and both the money and the market will gradually fade away. We have thebest natural conditions for growing the certified seed and also the prodiguous seed growers will have produced the best seed. The certified seed potatoe industry brings $12 to $15 million to Montana each year. The growers support all

the programs certification research, lab space, equipment and the salary of the personnel. They have never had a bit of state funds, nor has any University money been used in this program, and because of no help they have a tough time competing. He showed a chart and the savings in time through this rearch for the grower. He said the equipment is expensive, but can save 2 years of testing. The technique is available, and Montana Seed Industry has an unlimited potential.

Wilbur Ken, seed grower in Galatin County said they have been fighting the disease and virus and that today with the research going on there is a lotmore living organisms eating away at our ptoatoes than we had thought. Other states are working on this too, it is a competitive business. We have the reputation of producing some of the best seeds in the North West. To stay on top, we have to continue our research and development.

Don Lake, seed potatoe grower from Lake County said this money is put in and designated to disease research. We need it to keep on top, and the expense is really big to the producer.

Steve McCullough, seed grower from Townsend said, I moved to Montana to be a seed potatoe grower. I had worked in Washington but here we are doing a research study on the best program in the West. Montana showed the best program. I left Washington and came here to participate.

There were no further proponents, no opponents, and Senator Himsl asked if there were questions of the committee.

Senator Aklestad: I am wondering, you say no money, yet the lab and greenhouse in Bozeman, isn't that money? Mike Kohnke: There are no University funds going into that at this time. The growers put in money with the Long Range Building Program on the greenhouse and we get to use the basement and the greenhouse for 3 months.

Senator Aklestad: Why not? Kohnke: Certification of clean seed and the seed potatoe industry has to pay its own way. The state law says so.

Senator Aklestad: There is no money from the state? Kohnke: They may do some research at the experiment station, but not with us.

Senator Aklestad: Does Mr. Sun work there? Kohnke: He is an employee of the University, but we pay his salary. It goes into a designated fund for certified seed potatoes and he gets his pay out of this.

Senator Haffey: This bill went from $30,000 to $60,000 and back to $50,000. Is this going to build a green house? Kohnke: No. It is research.

Senator Haffey: If not researched at the University, why isn't it in the other program? Spuds are an agricultural program.

Dr. Sun: Before the bill was introduced I talked to the Department of Agriculture at MSU. He said to me that the potatoe is not on the list. They wanted to continue existing programs and not to add any additional research.

Senator Haffey: What is the $50,000 being used for? Sun: Research for the growers. We want to install the program to clean up the diseases for the grower. This is the initial installment and will help to get the grower on his feet.

Senator Himsl: It is for the study of potatoe diseases. It is for research and development. They want to convert the technology into development.

Senator Aklestad: The assessment to produeers. What account does that go into now for certification? Sun: Nothing for the grower to sell seeds. It has to be certified.

One of the growers said that on the regulatory aspect of certification the University has the final word. There are 5 members

elected from each district, and the state is divided into 5 district The head of the Extension, Department of Agriculture and 3 from the University are on the board. They set the rules and regulations for potatoe certification and approved by President Teitz. We are talking about money for testing and finding the diseases in potatoes. We need the help in this area. It was so cumbersome in the past. I had 30,000 plants numbered out in the field. A crew has to come out and pick a leaf off and put it in a tube. It is taken to the lab and tested. There are about 1/2 million units tested in the lab. It takes a lot of labor and a lot of expense. The new method of elysa testing, we can sent tubers into the green house and test them there. It is expensive equipment, but it saves 2 years plus a lot of labor.

Senator Aklestad: Certification is not in this bill. Kohnke: We were cut out of the budget.

Senator Aklestad: When? Kohnke: About 1 1/2 years ago. Aklestad: Did you pursue it? Dr. Sun: Last year.

Senator Regan: If you get the grand and the program is funded what about 2 years from now. What will fund it then? Toft: That is a fair question. I checked with the fiscal analyst. It will not become a part of the base.

Senator Regan: I would like to ask Mike, two years from now are you going to be back in? Mike: No. Once the initial thing is started, from the academic to the applied science we will be asked to do that.

Senator Keating: Would this money be used to start the seed bank. Would you actually take the seed off and start the seed bank to get the best seeds to the producers? This program was $30,000 from the general fund then went to $60,000 and now is cut back to $50,000 from the renewable program. Mike: Dr. Sun had several other projects he was going to look into. Soil disinfectants, machinery, etc. That is all cut out.

Senator Keating: How soon do you have seeds to stick in the ground? Kohnke: In this biennium.

Senator Nelson: 4 years ago they decided not to do it. Kohnke: Now the University and Dr. Sun have a better understanding. It takes a lot of science and Ph D's to do it.

Senator Himsl: You are talking about a lot of expensive scientifi equipment. Kohnke: The growers have bought most of it. In this you have to buy some. The Montana State University and the State of Montana own the equipment.

Senator Haffey: Looking at the map, the area of potatoes growing, what you are talking about in terms of potential? Suppose Montana does do wonderful things, how does that affect what we are looking at?

Senator Smith: Montana grows only one variety. If we can increas and get more varieties that the neighboring states need, they will take more out of Montana. Washington exports seed for trial in South America and China now.

In closing, Representative Thoft said he felt the issue has been discussed and he would hoped the bill would get favorable consider ation.

CONSIDERATION OF HOUSE BILL 19: Representative Bengtson carried the bill for Representative Donaldson who could not be here today. She said this is a bill for retired senior citizens. This is an appropriation to the retired senior citizen volunteer progra which is a community program for persons 60 years or over. The RSVP will continue to involve themselves in community life and help improve the lifestyle of not only other senior citizens but everyone in the community. She said the program gets the Senior Citizens our into the main stream of life to do volunteer work in libraries, meals on wheels, community projects, or wherever they canhelp. This does not come out of the Older American Act that comes out of the Council on Aging. It gets a lot of service for the money you put in.

Donna Eldrich, RSVP director from Helena is representing the RSVP projects in Montana and fully supported the program.

There were no further proponents and no ooponents, and the Chairman asked if there were questions from the committee.

Senator Regan: This is a lot of federal junds, and I have the same concern I have in every one of the appropriation bills. Bengtson: I don't know. Regan: What do you hear on the federal question? Eldrich: As of last week it is approved until--well it is approved for the coming year and the next year. They gave two but requalified the aging agency. I don't think it will be a problem.

Senator Smith: In paragraph 3 of the cover letter on House Bill 19 it says it would be local junding provided by local counties, United Way, etc. The money is all put together?

Bengtson: 70-30 match. The state appropriation will go to SRS and they will allocate it out to the different projects and on a matching basis they will get federal funds.

Senator Smith: I have one in our area. The county money would not go to SRS but will remain and you will get the federal and the state. Bengtson: Yes.

Senator Regan: Is there anyone here from SRS? I understand there is no administrative costs from SRS on this taken out of the appropriation. This is simply a pass through and no reason for your not taking a cut.

Senator Keating: I would like to know how the program works. Why does it cost money to get people to volunteer? Bengtson: You need somebody to coordinate. One administrator takes care of 140 volunteers, make contact with local libraries, boards and groups and clubs. Eldrich: The reason we need an administrator is the regional success of the program is to get the elderly out of their home and keep them active. This is the role of an administrator to try to bring people out. People that perhaps never had much of a social life. When retired may sit at home and do nothing. These people that are not active--to bring them out and let them contribute to the worthwhile projects and to society.

Senator Dover: I don't see anything in state funds. Is this something we contribute as a new program? Eldirch: In many cases the funds will no longer be available and the second reason is that the program is growing so fast there is not enough in local areas to get matching funds.

Senator Aklestad: Isn't this being handled by local direction in the senior citizens in the area? Eldrich: We do supply some of them. The majority succes is to place them where they are not necessarily involved in senior citizen groups. Schools, libraries, clubs, etc.

Senator Boylan: How come it is not in the regular appropriation budget? Bengtson: It comes out of a program called action. It is not handled through the area council of aging. It is a different program that is handled in SRS.

Senator Himsl: The success or failure depends on the energy, enthusiasm and originality of the person who generates the program. If you have a lively person they will hustle the people around. She hustles the service clubs for what she can get out of it. Whether the program succeeds depends upon the director Bengtson: Perhaps Rep. Donaldson could have answered some of the questions better. We could have brought in a room full of senior citizens. The program stands on its own. It has been very successful, it is popular and a worthwile program.

There were no further proponents, no opponents, and Senator Himsl asked if there were questions from the committee.

Senator Story: How long has the program been in existance. Eldirck: 10 years.

Senator Story: Have they had general funds before? Bengtson: Th dropping off of local funds now is the reason for this request.

Senator Aklestad: What local funds are drying up and why? Eldric Because fo the growth. There is some funding, some permissive mills--in most areas they are not levying the full mill. The costs are more for transportation for volunteers, insurance. We were making it, but because of the growth the money is simply not there.

Senator Aklestad: The money would be available if they go up to the too mill levy? Eldrich: They are using some of that money for home health care, etc. now, the senior citizens nutrition program, etc. We do not want to take money out of those programs, they are needed.

Senator Smith: On page 2, line 8, would this money be used to go into the area and expand it or used through the 11 districts now? Bengtson: The 11 they would each use it and if any left over it could be used for expansion.

Representative Bengtson said she had no further closing remarks and the Chairman declared the hearing closed.

CONSIDERATION OF HOUSE BILL 568: Representative Hemstad, House District 40, said this is an appropriation of $200,000 from the general fund to the superintendent for the gifted and talented childrens programs. The $200,000 has been amended down for a consultant and a part time secretary. We deducted that cost. It is written in for grants only. She explained that some childr had learning problems that were not because they were special education kids, but because they were bored with the subjects and need a challange. By finding a way for them to use their creative talent they could become top students, either through advanced courses, or a creative project of some type. They were identified by intelligence tests, teachers, parents, school authorities, etc.

Nancy Lukenbill, OPI, said they support the program. She felt it was necessary to meet the constitution requirements which state that they shall establish a system of education which will develop the full potential of each person. She said there is a test called the Ross test which will help to identify these students. We now have 20 schools with no program that would like to study the option.

As a teacher in secondary system for 29 years, I have had kids ranging from an IQ of 80 to 160 or 170 level. For a teacher to try to keep the students going is an enormous broblem. He said he recalled reading about a boy who came to school and the first day he ran home and said he was not going to that dumb school. Fortunately they took him to the University that tested him at 180 IQ. The kid was taking calculus. By logic he can drive the professor to the wall and pin him there. He is just too bright. I had a girl in class that was bright. She never said anything unless I asked. She is teaching in Harvard now. This bill is only asking for $200,000. There is $27 million on the other end of the scale.

Dr. Santus, Boulder spoke for the bill with a little reservation. He mentioned section 27-901. He said these children are a great natural resource and are being wasted. This minority may someday solve our national problems. My only problem is it is not a small task, and it might be one of three in the whole program.

Gail Hanninen, Kalispell, Montana, a gifted program coordinator. She said the intent is to see that each reaches their potential. She passed out a blue fact sheet. She said this describes the Kalispell program.

Jean Monforton, Kalispell, Gifted and Talented Program, said she was speaking as a parent. Prior to being enrolled, her children expressed frustration in many of the things they did for the 2 years before. They were children with above normal mental capabilities and were having trouble being kept behind. She said they are changed children and she felt the gifted and talented program should be part of the basic education.

Kirsten Statz, 6th grader said he was in an excellerated program and it was good to know there was someone else in the school who had the same value as you. The kids do a lot of teasing and everything.

Vicki, an eighth grade student in Bozeman said she like her program. If you pass this bill it will give us a chance to solve some of the problems when we grow up.

Charlie Seastone, School Board Association said he had a daughter that has shown a lot of progress in Helena. She entered School and knew how to read and do math. The teachers thought she needed help since she would just put her head down on the desk. She is now in this program and doing great.

Owen Nelson, Montana Education Association. The MEA has promoted

this type of program for many years. We feel it should be for the gifted as well as the handicapped. This would help the districts set programs and goals.

Shirley Devoe said this was a pilot program. We hope you will look at the testimony my husband and I put together. We had looked at the fact that being bright is not always pleasing. We should stress a teacher has 20 to 25 children. We realize we are spending the funds here we will be getting $1 for every 10¢ expended and with the special education program too often we are getting 10¢ for every $1 expended.

Harriet Meloy, the Board of Public Education has vigorously supported gifted and talented programs in Montana for a long time. We developed a strong policy in 1975 from the board. We have watched programs grow in cities in the original communities and have been very concerned in smaller communities. This is a small amount and we should have funds to spread over the state of Montana. There are drop outs, children being bored in every part of the state. We think you should look favorably on this amount of money.

Nathan Keets, Butte, said a child goes into a class room and is told to shut up. If you have a chance to put them into a program and go at it and think of the future they will not become bored. I think you should think of developing their future for us. I think we should fund this program for our future.

There were no further proponents, no opponents, and the Chairman asked if there were questions from the committee.

Senator Jacobson: When you wrote the bill, did you mean to have the consultant in it? Hemstad: Having it already in House Bill 500 we decided to do a little cutting back. Senator Jacobson: The amount for it is what? Hemstad: $65,000.

Senator Regan: The administrative program is high. Hemstad: This is matched. Line 22 and 23 talks about that. This will be matched. She read from part of the bill.

Senator Dover: It gets back to where we offer the education to the kids. $27 million for the ones that need help because they don't have the mentality. Why not more of a balance? Why not develop this tremendous potential?

Senator Smith: I don't think you should over look that we increased the foundation program 18 and 15% in this biennium. This is the first time this type of contribution has been given to the schools for a number of years.

Senator Aklestad: Who is to identify them and then what happens? Gail Hanninen: The identification procedure has 4 categories. It is done through a number of ways, testing procedures, parent identification within social and emotional scars. There is a procedure for identification within 4 categories. The programs are then developed to meet the need.

Senator Aklestad: What type of program? Answer: They finally range from content oriented to creativity; problem solving, one community addresses some of the local needs by having the children participate in the problem solving pool.

Senator Aklestad: Why wouldn't they just be advanced in grades up? Answer: We looked at a number of ways, horizontal, vertical and augmented programs. The student may not be accelerated in one subject, but is in others.

Senator REgan: Would you have the program on what they are doing in Great Falls? (they did not have anything with them).

Senator Smith: All special education program money is not being used for mentally retarded. It can be used for many other areas. If there is a problem, it can be used.

Senator Aklestad: Is there any reason why the existing budget can't be used for this? Hemstad: It can be. We have 34 out of 700 school districts involved here. 9 districts on federal grants, 4 on foundation money. 6 districts on title 4 money. Many local dollars have been spent. The building up these last 2 years, grants for $113,000 in the state. Some are on three year grants. I have a lot of all those properties serving students. There are some ready to serve students in September. The first year is in planning before any start working with the students themselves.

Representative Hemstad closed by saying the gifted and talented have been clearly misunderstood. The local school districts spend thousands of dollars on athletics. Great Falls had a number of cutbacks. A number of teachers were ready to go, they also cut back on programs. PACE was cut back. Parents had a fit and they had to reinstate that program.

Senator Himsl declared the hearing closed.

CONSIDERATION OF HOUSE BILL 290: Senator Himsl explained that this bill had been heard a few days ago and there had been some problem with it. There were some proposed amendments passed around. The amount of funding in House Bill 500 is based on the 175 level and not on the 200 level present in the bill now. If you go with this bill or change it you will have to put in more money. In changing this we will have to go to 500 and make up the difference.

Senator Haffey: House Bill 500 has money in it at current level. One of which is this thing until we saw what the figures in this bill were.

Senator Himsl: This does not go through as a separate bill. The funding is in 500 and must be changed there.

These amendments, Senator Regan prepared and it relates to the spouses, etc.

Senator Dover: We have raised it up to 7-5, why is the original amount left?

Senator Himsl: The spouses were in there originally.

Senator Jacobson: Wasn't the funding in 500? Curt Nichols: The funding in House Bill 500 was based on the law in effect prior to this session. It is based on the full pay 1/2 level and the $175.

Senator Keating: This amendment will cost $200 to $250,000.

Senator Smith: If this amount passes, if the spouses could get up to $10,000 a year. I know people who cannot get that much working. They can earn up to $7400, then get $200 a month. 24 and 74 maked 9800.

Senator Van Valkenburg: How many widows are there in Butte that can make that much a year?

DISPOSITION OF HOUSE BILL 290: Motion by Senator to adopt the amendments.

Senator Dover: I make a SUBSTITUTE MOTION to change the $7,500 to $6,800.

Senator Himsl: Why?

Senator Dover: Just going by the original bill.

Senator Etchart: According to testimony there are 224 widows: that leaves 175 on 1/2 pay. The increase of $100,000. My calculations would be $175 more per month.

Senator Aklestad: Where the language is struck, there where it has the figures, does that have to be put back in?

Senator Himsl: Maybe we are not sure enough of what we are doing. Let's have the fiscal analyst work on it. We will carry it over until next time.

DISPOSITION OF HOUSE BILL 45: This is a cost of 50¢ per month on the teachers retirement system.

Senator Dover: I would move the technical amendments we were handed out the other day. Page 44, line 6 following: "retired" insert "on or after July 1, 1975".

Senator Jacobson, would we have to remove the other language?
Dover: No.

2. Page 47, line 22, insert contribution shall be 14.4 instead of the 15.

Voted and passed, the amendments were adopted.

MOTION by Senator Dover to move the bill be concurred in as amended.

Senator Aklestad: I hope you recognize we are putting more pressure on the local governments who pick up some of this tax. I am not sure we can deep factoring in the inflationary figures. It is self perpetuating.

Senator Story: That is true. The Drake amendment, when it causes the local government to incur an increased cost, we have to tell them where it is coming from.

Senator Himsl: It will come out of taxes. That is where it is coming from. The city general all purpose levy is supposed to be 60, of the whole area. It is 100 mills. Out of that all programs are added in.

Question was called, roll call vote, the bill was passed, Senator Stimatz to carry the bill.

DISPOSITION OF HOUSE BILL 568: Senator Dover moved House Bill 568 be concurred in.

Senator Story: There is one thing I would like to point out. It is just like kindergartens. What you have got is both barrels from the biggest and most talented industry, Education. You are really talking about pumping more money into the education machine. It is how much you are going to pumb into the education machine to pump it up. Those schools can perform those if they really want to do it. You want to rationalize them getting more A & B -- fine. It may help some kids and create a foundation for a new class of readers. They can come in 2 years from now.

Senator Jacobson: Spending $51 million on special education. A lot of the money is going to identify the kids that can't say "R's" correctly. Here we have a chance to identify our top 2% of the kids and so many of them have serious emotional problems. The schools are not meeting these nees. I know a kid with an IQ of 160. He gets a stomach ache at school, will go into a library and seek out books and go home.

Senator Jacobson: The only way we get it is after they are emotionally disturbed and then he gets it. We have to let them know they are not unusual in a bad way. Our school system today doesn't do that. We just don't have a way to do it.

Senator Haffey: We have places they have incorporated some program in their present system. In some places they are just working on it to add it to the system. Most of us just fall into the cracks.

Senator Regan: You may recognize these kids. Unless some help, some measure to provide for them. This is just a token to tell the districts they should do something.

Senator Himsl: This will not do much of the job.

Senator Story: You will have this again 2 years from now.

QUESTION was called, roll call vote, the bill passed, and the vote was 10-4. Senator Bob Brown will carry the bill.

DISPOSITION OF HOUSE BILL 19: Senator Himsl said this was an appropriation of $100,000 for the senior citizen volunteer program.

Senator Johnson: I would move we concur in House Bill 19.

Senator Story: This is something never in before in the general fund. As the federal funds drop off we should not pick up the funding. It is no easier if we pick up programs on a block grant. It would be low on my priority. We are promoting a bureaucrat to insure them getting a program somewhere.

SUBSTITUTE MOTION by Senator Dover DO NOT CONCUR. Voted, passed 9-

DISPOSITION OF HOUSE BILL 469: Motion by Senator Dover that House Bill 469 be concurred in. If we do that no cost can go to direct cost or administration.

Senator Regan: I would move to amend the bill to have the boiler plate language indicate it is a grant for research only and no indirect cost be taken out of it.

The Motion to amend was voted, passed.

The motion by Senator Dover was changed to BE CONCURRED IN AS AMENDED.

Senator Smith: There is no money for certification. That came in and asked for that specific purpose.

Senator Story: Seed potatoes. We have the amendment that says no administrative costs are siphoned off by the Agricultural Experiment station.

Senator Story: If general fund instead of renewable resource fund, if it is they don't waste it on this project, they will waste it on some other project.

Senator Haffey: Are we to see this as being on their priority list next time? We had 20 last time, will there be 21 next time-- I am talking about the Agriculture budget. How do these things sneak in? Story: This way.

Senator Nelson: This has been a big fight. The certification is. All they want to do now is to start a plant to try to keep the diseases out of it.

Senator Himsl: Senator Story's observation is true. This is being proposed out of renewable resource development funds. We do have an obcession or obligation to spend it all. It may as well go here as somewhere else. I do have a question as to whether this is really a renewable resource.

Senator Smith: Spuds are a renewable resource.

QUESTION WAS CALLED and the bill was voted TO CONCUR IN AS AMENDED, passed, Senator Boylan to carry the bill.

The meeting was adjourned at 11:48 a.m.

SENATOR HIMSL, CHAIRMAN

COMMITTEE FINANCE AND CLAIMS

Date _____ Bill No. 95 Time 11:3_

NAME	YES	NO	ABSENT	EXCUSED
Senator Etchart		✓		
Senator Story	✓			
Senator Aklestad		✓		
Senator Nelson		✓		
Senator Smith	✓			
Senator Dover	✓			
Senator Johnson	✓			
Senator Keating		✓		
Senator Boylan	✓			
Senator Regan	✓			
Senator Thomas			✓	
Senator Stimatz	✓			
Senator Van Valkenburg	✓			
Senator Haffey	✓			
Senator Jacobson	✓			
Senator Himsl	✓			

Sylvia Kinsey
Secretary

Senator Himsl
Chairman

Motion: [illegible]

SENATE COMMITTEE FINANCE AND CLAIMS

Date 4/11 Bill No. [illegible] Time [illegible]

NAME	YES	NO	ABSENT	EXCUSED
Senator Etchart	✓			
Senator Story	✓			
Senator Aklestad		✓		
Senator Nelson	✓			
Senator Smith	✓			
Senator Dover	✓			
Senator Johnson		✓		
Senator Keating			✓	
Senator Boylan	✓			
Senator Regan	✓			
Senator Thomas			✓	
Senator Stimatz	✓			
Senator Van Valkenburg	✓			
Senator Haffey	✓			
Senator Jacobson		✓		
Senator Himsl		✓		
	10	4		

Sylvia Kinsey
Secretary

Senator Himsl
Chairman

Motion: [illegible]

SENATE COMMITTEE FINANCE AND CLAIMS

Date 4/4 Bill No. 365 Time 1:20

NAME	YES	NO	ABSENT	EXCUSED
Senator Etchart	✓			
Senator Story		✓		
Senator Aklestad		✓		
Senator Nelson		✓		
Senator Smith		✓		
Senator Dover	✓			
Senator Johnson	✓			
Senator Keating	✓			
Senator Boylan	✓			
Senator Regan	✓			
Senator Thomas			✓	
Senator Stimatz	✓			
Senator Van Valkenburg	✓			
Senator Haffey	✓			
Senator Jacobson	✓			
Senator Himsl		✓		

Sylvia Kinsey
Secretary

Senator Himsl
Chairman

Motion:

SENATE COMMITTEE FINANCE AND CLAIMS

Date 4-11 14 Bill No. 19 Time 1105

NAME	YES	NO	ABSENT	EXCUSED
Senator Etchart	✓			
Senator Story	✓			
Senator Aklestad	✓			
Senator Nelson	✓			
Senator Smith	✓			
Senator Dover	✓			
Senator Johnson		✓		
Senator Keating	✓			
Senator Boylan	✓			
Senator Regan		✓		
Senator Thomas			✓	
Senator Stimatz		✓		
Senator Van Valkenburg		✓		
Senator Haffey		✓		
Senator Jacobson		✓		
Senator Himsl	✓			

9 6

Sylvia Kinsey
Secretary

Senator Himsl
Chairman

Motion: Do Pass

STANDING COMMITTEE REPORT

April 11, 1981

MR. President

We, your committee on Finance and Claims

having had under consideration House Bill No. 469

(Taylor)

Respectfully report as follows: That House Bill No. 469,

third reading bill, be amended as follows:

1. Page 1, line 19.
Following: line 18
Insert: "This appropriation may be used only for research. No costs of administration or other indirect costs of the program may be funded by this appropriation."

Y.C.

And, as so amended,
BE CONCURRED IN
~~DO PASS~~

Senator Himsl Chairman.

STATE PUB. CO.
Helena, Mont.

STANDING COMMITTEE REPORT

April 11, 19 81

MR. President

We, your committee on Finance and Claims

having had under consideration House Bill No. 568

(B. Brown)

Respectfully report as follows: That House Bill No. 568

W.C.

BE CONCURRED IN

~~DO PASS~~

Senator Himsl Chairman.

STATE PUB. CO.
Helena, Mont.

STANDING COMMITTEE REPORT

April 11, 19 81

MR. President

We, your committee on Finance and Claims

having had under consideration House Bill No. 45

(Stimatz)

Respectfully report as follows: That House Bill No. 45,
third reading bill, be amended as follows:

1. Page 44, line 6.
Following: "retired"
Insert: "on or after July 1, 1975, but"

2. Page 47, line 22.
Followint: "~~14%~~"
Strike: "15%"
Insert: "14.04%"

And, as so amended,
BE CONCURRED IN

~~DO PASS~~ as C.

Senator Himsl
Chairman.

STATE PUB. CO.
Helena, Mont.

STANDING COMMITTEE REPORT

April 11, 19 81

MR. President

We, your committee on Finance and Claims

having had under consideration House Bill No. 19

Respectfully report as follows: That House Bill No. 19

W.C.

BE NOT CONCURRED IN

~~DO PASS~~

Senator Himsl
Chairman.

STATE PUB. CO.
Helena, Mont.

ROLL CALL

FINANCE AND CLAIMS COMMITTEE

47th LEGISLATIVE SESSION - - 1981 Date 4/6

NAME	PRESENT	ABSENT	EXCUSED
Senator Etchart	✓		
Senator Story	✓		
Senator Aklestad	✓		
Senator Nelson	✓		
Senator Smith	✓		
Senator Dover	✓		
Senator Johnson	✓		
Senator Keating	✓		
Senator Boylan	✓		
Senator Regan	✓		
Senator Thomas			✓
Senator Stimatz	✓		
Senator Van Valkenburg	✓		
Senator Haffey	✓		
Senator Jacobson	✓		
Senator Himsl	✓		

DATE 4/11

COMMITTEE ON F & C

H.B. 568, 19, 469, 854

VISITORS' REGISTER

NAME	REPRESENTING	BILL #	Check One: Support	Oppo
Donna Eldridge	R S V P Projects	19	✓	
GAIL HANNINEN	MONTANA AGATE / Kalispell S.D.5	568	✓	
Joan Monforton	Kalispell G.T. program	568	✓	
MIKE KOETTKE	Montana Seed Potato Growers Ass.	469	✓	
Don Lake	Montana Potato Imp. Assn.	469	✓	
Mike Syn	Montana State Univ.	469	✓	
Irene Fynn	Mont. Pot. Seed Growers	469	✓	
Wilbur Fynn	Mont Pot. Seed Gr	469	✓	
John Delano	MONT RR Assn			
Ralph Avery	BN			
John Willard	B N			
Owen Nelson	Mont. Educ. Assoc.	568	✓	
Nancy Lukenbill	Mont Ass of Public Instr.	568		
Merle DeVoe	Parent	568	✓	
Shirley DeVoe	Parent	568	✓	
Jennifer DeVoe	Student	568	✓	
Viggo Andersen	Mont. Citizens Freight Rate	854	✓	
TOM TEMPLETON	MONTANA GRAIN GROWERS ASSN.	854	✓	
Steve McCullough	N.W. Potat. Sales	469	✓	
Jim Christiansen	MONT. WHT. COMM	854	✓	
Chas. V. Seastone	MT School Boards Assn	568	✓	
Gordon McOmber	D. of A.	854	✓	
KEITH KELLY	Dept of Ag	854	✓	
Gary Barbour	Dept. Business Regulation	854	—	
2V SANTOS MT	SELF	568	✓	
Nicky McKoch	Bill 568		✓	

(Please leave prepared statement with Secretary)

DATE _____

COMMITTEE ON _____

VISITORS' REGISTER

NAME	REPRESENTING	BILL #	Check One Support	Check One Oppo
Jo Brunner	W.I.F.E	85-4	✓	
"	Mont Farm Bu.	"	✓	
"	" Cattle feeders	"	✓	
"	ASARCO	"	✓	
Kenneth D Clark	United transportation union	854	✓	
Joe Brand	SCIF	854	✓	
Mons Teigen	Lt Stockgrowers Cowbelles Woolgrowers	854	✓	
Brian McCullough	DCA	854	✓	
Chuck Lozzgen	HD 64	85	✓	✓
KAREN TRACH	parent, gifted	568	✓	

(Please leave prepared statement with Secretary)

House Bill 854 - Proposed Transportation Division in the Department of Commerce

Montana's economic base is primarily built upon extractive-type industries. This means that the industrial base of Montana's economy produces commodities which are bulk in nature and because of our lack of poulation base, these bulk commodities require movement to destinations outside the boundaries of the state in order to be of economic benefit to our citizens. We produce large quantities of coal, grain, lumber, livestock and products of the mine. To these industries efficient and economical transportation is not just a necessity, it is survival.

If we are to remain competitive with other states, our Montana industries must secure adequate transportation at reasonable transportation rates. Our transportation problems are not just railroad oriented but we have problems with truck service, passenger service, urban transportation service, rural transportation service, transportation of people - livestock - bulk commodities and manufactured commodities.

It is in the best interest of the state to consolidate the transportation service bureaus within state government. It is also in the best interest of the state to elevate those functions so that they can become more efficient in dealing with our massive transportation problems.

The proposed transportation division will consist of three bureaus: (1) a litigation and analysis bureau; (2) a planning and implementation bureau; and (3) a transportation assistance bureau.

Litigation and Analysis Bureau

The litigation and analysis bureau would be beefed up and provide the necessary transportation economic costing necessary to carry the required burden of proof in transportation litigation matters. This bureau accounts for the main increase in funding. Activities currently residing in the transportation portion of the Marketing and Transportation Unit at the Department of Agriculture would be moved to this bureau.

The need for an increased litigation section is because that under the new Staggers Rail Act, the burden of proof for rate increases now rests with shippers. Unless market dominance determinations are successfully litigated, the shippers may have an impossible burden to fulfill. The data required to litigate rate matters is unavailable to shippers due to the expense and complexities.

In the past the carriers had to show the ICC that they needed the increase before it could be granted. Now the shipper must prove that the carriers don't need the increase.

Planning and Implementation Bureau

The planning and implementation bureau will carry out planning and project implementation under Title 803 utilizing 20/80 federal matches. The program will deal in planning predominantly of the rail networks within the state and also coordinate planning and projects with other transportation planning agencies within state government. The initial state rail processes are complete and the bureau is starting to implement projects. They will be involved in rail reconstruction, ties, facilities, etc. The addition of the traffic inspector is needed just like highway inspectors are needed for inspection of projects.

Transportation Assistance Bureau

This bureau deals primarily in people transportation and will provide assistance to people and groups with special transportation needs. This bureau is being transferred intact from the Department of Community Affairs. The transportation Assistance Bureau will deal in specialized transportation problems, urban transportation problems and rural transportation problems dealing with people.

H.B. 854
TRANSPORTATION DIVISION

A-1

Position: Administrator

Duties: Performs complex professional and administrative duties in identifying and analyzing the transportation problems and solutions potentially existing in the State of Montana.

Examples: Performs analyses to develop and administer a short-range, intermediate and a long-range plan for transportation development in Montana; develops and coordinates transportation planning and transportation assistance to develop effective programs to deal with transportation problems; coordinates efforts with various local, state and federal agencies, and all other relevant individual, organization, and institutions on state, national and international levels; develops technical assistance for communities; represents the Transportation Division in litigation matters; makes recommendations pertaining to transportation developments; performs related work as required.

A-2

Position: Administrative Assistant II

Duties: Performs a variety of technical administrative functions of average difficulty.

Examples: Assists with a variety of functions such as budgeting, inventory, purchasing; employment and counseling; assists in scheduling and participating in meetings; in the development of policies and procedures and programs; preparing reports; answers correspondence concerning agency policies; composes and signs correspondence; researches and writes editorials and news releases; draft grant applications; may assume responsibility of supervisor in his absence; may require typing; performs related work as required.

Litigation and Analysis Bureau

The Litigation and Analysis Section will be designed to (1) perform various litigation efforts; (2) develop analytical expertise to allow analysis of transportation problems and development of solutions; (3) develop the in-house expertise to produce cost and rate data which will provide the basis for litigation; and (4) assist the Planning and Implementation Bureau and the Transportation Assistance Bureau in development of their coordinated programs.

In this section the following positions are justified:

B-1

Position: Chief - Litigation and Analysis Bureau

Duties: Develops litigation and analysis under broad policy guidance and direction, performs administrative, supervisory and professional work, represents through litigation and implements litigation and analysis backup for the Transportation Division of the Department of Commerce.

Examples: Evaluates transportation conditions as they may effect Montana transportation users; analyzes and sets priorities for participation in litigation cases; develops Montana's case-in-chief before the Interstate Commerce Commission, the Montana Public Service Commission and Courts; represents Montana transportation users at hearings; practices administrative law before the Interstate Commerce Commission and Courts; oversees development of transportation economic data and evidence for proceedings; performs related work as required.

B-2

Position: Transportation Specialist III

Duties: Under broad guidance and direction performs administrative developmental and professional work in implementing the surface transportation program of the Department of Commerce. This class exercises supervision over unit personnel directly or through subordinate personnel.

Examples: Evaluates transportation conditions as they may effect Montana transportation users; analyzes freight rate proceedings; develops Montana's cases-in-chief before the Interstate Commerce Commission and the Montana Public Service Commission; represents Montana transportation users at hearings, and testifies as an expert witness; practices administrative law before the I.C.C.; responds to new or proposed legislation on behalf of Montana transportation users; develops transportation data and evidence for proceedings; advises Montana transportation users on transportation matters; assists in implementation of a state transportation program; performs related work as required.

B-3

Position: Paralegal

Duties: Under the close supervision of lawyer(s) performs research, investigative and administrative work in assisting lawyers in various legal and administrative activities. May exercise supervision over clerical and secretarial personnel.

Examples: Researches and analyzes sources such as statutes, judicial decision, articles, depositions, treaties, legal codes, land titles and abstracts and regulations; prepares abstracts and reports of research findings; compiles citations and references. Assembles exhibits, affidavits and other documents; checks citation, quotations, footnotes and references for accuracy; explains previously interpreted laws, rules and regulations to others; may assist in the preparation of various legal and administrative documents. Arranges interviews and depositions and may assist lawyer to conduct, record or summarize interview; delivers or directs delivery of subpoenas to witnesses and parties to action; files pleadings with court clerk; may coordinate and direct activities of office staff; performs related work as required.

B-4 Position: Secretary III

Duties: Performs a variety of secretarial and clerical duties of considerable difficulty and some routine administrative duties for the chief of the Litigation and Analysis Bureau.

Examples: Composes correspondence on a variety of subjects requiring routine knowledge of policies, procedures, and functions of the agency; types correspondence, reports, legal documents, and a variety of other material; arranges appointments, meetings and travel schedules for the supervisor; handles clerical and administrative details of projects and events for the supervisor; maintains confidential and administrative files; prepares and maintains expense, payroll and statistical records and reports; arranges correspondence for supervisor's reply in order of priority; may take and transcribe dictation; performs related work as required.

B-5 Position: Analysis Section Supervisor

Duties: Under broad guidance and direction, performs administrative, supervisory and professional work in development of a transportation economic analysis section for the transportation program at the Department of Commerce. This position exercises supervision over personnel directly.

Examples: Evaluates transportation conditions as they may effect Montana transportation users; analyzes rates and economic costing; develops evidence for Montana's cases-in-chief before the Interstate Commerce Commission, the Montana Public Service Commission and the Courts; performs complex costing on various transportation modes and identifies and analyzes the economic framework and rate bases existing in the transportation system in the State of Montana; assists in statistical analyzing of changing transportation conditions; advises and provides technical assistance to litigation chief; plans, introduces, reviews and adopts statistical procedures and

costing methods; prepares and reviews as well as edits reports, studies, and evidence; coordinates activities with other sections, testifies as an expert witness; performs related work as required.

B-6 Position: Transportation Economist II

Duties: Under broad guidance and direction performs data accumulation and analysis at a professional level, implementing the surface transportation program of the Department of Commerce. This position exercises supervision over unit personnel directly or through subordinate personnel.

Examples: Evaluates transportation costs as they may effect Montana transportation users; analyzes freight rate filings, tariffs and proceedings; provides the statistical and analytical support data to the Transportation and Litigation Bureau necessary for its activities; testifies as an expert witness in various proceedings as required, before the Montana Public Service Commission, the Interstate Commerce Commission, state and federal courts. Compiles data and prepares analytical studies and reports such as Rail Form A and such subsequent reports as may be developed by the I.C.C. as a formula for use in determining rail freight rate service costs, to refute or support proposed tariff changes as may be appropriate to protect the interest of Montana transportation users; to assist in responding to new or proposed transportation and to assist in proposed legislation on behalf of Montana transportation users; assist in implementation of a state transportation plan program; performs related work as required.

B-7 Position: Rate Analyst

Duties: Performs professional work analyzing transportation within the state.

Examples: Responsible for analyzing freight rate structures to maintain current freight rate information on shipments of products; assembles rate evidence for hearings; provides technical rate expertise for the State of Montana shippers; checks tariffs for compliance with rules and terms of statutues; studies proposed rate changes and the effects of such changes; participates in activities relating to transportation trends, policies, services and rates; performs related work as required.

Transportation Assistance Bureau

The Transportation Assistance Bureau deals with Urban Mass Transit Administration (UMTA), and Federal Highway Administration (FHWA) funding for various programs dealing with the transportation of people. The program administers various funds which provide capabilities of conducting special transit-related studies, planning assistance, special assistance - the elderly and handicapped, and maintains a statewide transit inventory.

The bureau administers a program for the transportation of elderly and handicapped people (8% of the total budget), a program which provides assistance for communities less than 50,000 population (15% of the total budget). The bureau also has the responsibility for preparing transit-related studies, providing transit planning assistance to localities, assists in the administrative costs of the elderly and handicapped transportation program and providing conferences to educate transit providers and operators in the technical aspects of transit movements. The bureau also maintains a current statewide transit inventory, coordinates transit agency needs relative to legislation, maintains coordination of transit systems within the state, and has a transit library for access by interested persons.

In this section the following positions are justified:

C-1

Position: Chief - Transportation Assistance Bureau

Duties: Performs administrative supervisory and complex professional planning and research for a particular state agency.

Examples: Assigns work and supervises other planners in the collection of research data, etc.; provides coordination to and from the Planning and Implementation Bureau and the Litigation and Analysis Bureau within the division.

C-2,3

Position: Program Manager (2)

Duties: Performs administrative, supervisory and complex professional planning and research activities for a particular state agency.

Examples: Assigns work and supervises other planners in the collection of research data; supervises documentation and analysis of data; attends public meetings and departmental conferences; meets and confers with a variety of federal, state and local officials; coordinates activities among local and state agencies; reviews special studies conducted by consultants; makes comprehensive recommendations that the local and state governments fulfill policy and objectives; assists and encourages the development of local and regional planning programs; assists in developing agency budget and general policies, guidelines and objectives of agency planning programs.

-4 Position: Secretary III (½)

Duties: Performs a variety of secretarial and clerical duties of considerable difficulty and some routine administrative duties for the chief of the Transportation Assistance Bureau.

Examples: Composes correspondence on a variety of subjects requiring routine knowledge of policies, procedures, and functions of the agency; types correspondence, reports, legal documents, and a variety of other material; arranges appointments, meetings and travel schedules for the supervisor; handles clerical and administrative details of projects and events for the supervisor; maintains confidential and administrative files; prepares and maintains expense, payroll and statistical records and reports; arranges correspondence for supervisor's reply in order of priority; may take and transcribe dictation; performs related work as required.

The Planning and Implementation Bureau of the proposed Division of Transportation will be assigned the following responsibility:

1. Maintain State Rail Planning.
2. Catalize the development of an overall Transportation Needs Study.
3. Implement Rail Facilities and Rolling Stock Loan Programs.

As a result the following staff assignment is justified:

D-1 Chief - Planning and Implementation Bureau

General Duties - Performs administrative and supervisory duties in coordinating bureau activities and responsibilities.

Example of Duties - Directs bonding and loan activities; prepares budgets; engages consultants; negotiates contracts; reviews planning programs; participates in planning detail; serves as liaison within the department, between agencies (state and federal); general public relations; related work as required.

D-2 Secretary III

General Duties - Office support.

Example of Duties - Clerical; filing, typing, related assignments.

D-3 Supervisor - Intermodal Planning Section

General Duties - Performs supervisory and professional duties in state transportation planning.

Example of Duties - Designs and implements planning studies by identifying objectives, area and scope of study, type and amount of data required, required analysis techniques, and developing procedures and priorities; maintains liaison with other agencies, groups, and officials to coordinate studies, gain cooperation, provide information and to explain analyses and recommendations; directs and participates in planning studies by researching, gathering, and analyzing data and developing recommendations; prepares planning reports, legislation, grant applications and presentations; compiles data, analyses, recommendations and explanations into written narratives, graphs, charts, and other formats. May arrange public involvement programs to gain input and explains plans to the public; may monitor existing programs and projects to ensure compliance with rules and regulations and to suggest improvements in operations; may participate in the development and analysis of budgetary and program plans, goals and priorities for the planning function; performs related work as required.

D-4 Planner IV

General Duties - Performs complex professional research and analysis in conducting and directing program and project planning activities.

Example of Duties - Participates in the design and development of planning studies by identifying areas of study, type and amount of data required and required analysis techniques; researches and gathers data through such methods as literature and document review, field observations, questionnaire surveys and personal interviews; analyzes and evaluates data by statistical, financial, classification and other more difficult administrative, empirical and scientific techniques to draw conclusions and interpretations and to develop recommendations; prepares planning reports, grant applications and presentations; compiles data, analyses recommendations and explanations into written narratives, news releases, graphs, charts and other formats; maintains liaison with other agencies, groups and officials to gain cooperation, provide information and to explain analyses and recommendations; performs related work as required.

D-5 Draftsman III or Planning Tech I

General Duties - Drafting and mapping layouts; complex technical research.

Example of Duties - Prepares state transportation mapping, maintains statistical and inventory data and records; assists in inventory updating; updates routine reports and projections by adding new research findings.

D-6 Civil Engineer V - Traffic Inspector and Inventory and Project Manager

General Duties - Performs supervisory, inspection and professional data collection activities relating to specialized programs and projects.

Example of Duties - Provides professional engineering expertise in specialized data collection; prepares engineering estimates for planning implementation; reviews and/or prepares basic transportation project designs; provides required monitoring and inspection of construction activity (specifically railroad improvement projects).

House Bill 854 - Possible Areas of Questions

Q. What is the consolidation going to do? How will it be better than what we have today?
A. It will be a more financially efficient use of resources if located in the Department of Commerce. Transportation will work closely with economic development in that department.

Q. What kind of personnel will be employed and what will be their function?
A. The key is to hire technical and highly specialized people and not administrative personnel.

Q. We have had transportation problems for years -- how are we going to solve these problems now when we haven't been able to for years?
A. The State of Montana has never made a substantial commitment and has never spent the time and money necessary to solve the transportation problem. The Governor said problems won't be solved overnight, but we must start someplace.

Q. Why do you need more money than you already have?
A. With the type of work that we do, it is much cheaper to develop in-house expertise rather than heavy use of expensive consultants.

Q. Speaking of increased litigation, why can't the Attorney General do this litigation function?
A. The Attorney General doesn't have transportation expertise. The function of the Attorney General is to deal with general litigation and not specific, specialized litigation such as transportation.

Q. If we approve this, but not at the $297,000 level, how much money can be taken out of that appropriation and still accomplish the major purposes of the bill?
A. This would be a policy answer.

Q. Under dergulation, is there anything that can be done to help? With a railroad monopoly and deregulation, really what can be done other than spending money?
A. The Staggers Rail Act is really reregulation and not deregulation. The Interstate Commerce Commission still has jurisdiction, but the shipper instead of the railroad now has the burden of proof.

Q. The bill talks of planning, analysis and litigation for "all modes". Is it the intent to plan "highways" and "air systems" under the bill?
A. The bill is designed to allow coordination with those agencies charged with highway and airline planning, but not to do their planning for them.

Q. What about the Consumer Counsel?
A. The laws of the Consumer Counsel restrict them to practice only before the Public Service Commission. They do not have the staff to increase this functional responsibility.

Q. What about the Public Service Commission?
A. The Public Service Commission has no authority to represent transportation shipping outside of their jurisdiction.

Q. What happens if we don't approve this bill?
A. It would increase the burden upon the shipper from the Staggers Rail Act and there would be a decided lack of transportation coordination. With no increased effort there would be greater hardships upon the shippers because of increasing complexities of transportation problems. Also, with a lack of increased coordination with economic development there would be a "transportation bound" limit to industrial development created.

Q. How will the Governor's proposed Transportation Task Force interface with this new Division of Transportation?
A. The new Division of Transportation will probably be the resource arm of this new task force.

Q. How is this going to have a beneficial effect on the producers?
A. The actions taken by the unit, for example: market dominance, etc., will make it possible for the producer to be able to pursue representation of their own interests. This action will allow individual producers to then bring their own actions if they feel they can benefit more.

Q. Are the producers able to handle transportation litigation on their own today?
A. Before the Staggers Rail Act and corresponding shifts in buden, shippers attempted in one case to pursue a complaint. This complaint required assistance from state government on several occasions. The action was an attempt to recoup past overcharges, after the damage had been done. It is unfair and impractical to expect producers to put up litigation on a continuing basis for broad litigation work in all areas of transportation and economic analysis. The only legal mechanism to invoke ICC jurisdiction to challenge rates under Staggers Rail Act is upon a finding of market dominance of a transportation mode. First, this action requires a complaint of market dominance and after determination of that issue, a rate may be challenged which involves a determination of variable and fully allocated cost of a particular railroad operation. Rail costing data is not available to individual producers to pursue a rate challenge under market dominance yet they have an affirmative burden of proof on both of these points to be successful.

Q. Will Staggers Rail Act require continuing increased efforts or will the required effort diminish over time?

A. A railroad under Staggers Rail Act may establish a rate at any time it chooses, without regulation by Montana PSC or the ICC. The only condition where economic regulation can be invoked is under market dominance provisions which are probably applicable in Montana. The Staggers Rail Act is one of the most far-reaching pieces of transportation law to be enacted by the Congress since the Act to Regulate Commerce of 1887. It is the experts opinion that Staggers Rail Act provisions will set the tone for regulation of transportation modes for the foreseeable future.

WITNESS STATEMENT

NAME Jo Brunner BILL No. HB 854

ADDRESS 531 S Oakes DATE April 10

WHOM DO YOU REPRESENT W.I.F.E - ASRCO - MFB - MCFA

SUPPORT ✓ OPPOSE AMEND

PLEASE LEAVE PREPARED STATEMENT WITH SECRETARY.

Comments:

Mr Chairman, members of the committee for the record my name is J. Brunner and I speak today for Women Involved in Farm Economics in total support of HB 854

I ask your permission to submit endorsement for this bill from the Montana Farm Bureau - the Montana Cattle-Feeders and for Anaconda Smelting Refinery Co - Cadres as their representatives are not able to be here today. Thank you

Montana Farm Bureau

FORM CS-34
1-81

All Dollar Figures are for the 1982-1983 Biennium

H.B. 500 - Total Appropriated Funds Including General Fund, Earmarked, and Federal Funds

	General	Earmarked & Federal Funds	Total
Marketing & Transportation - DOA	$ 93,832	$ 100,000	$ 193,832
Transportation Assistance - DCA	16,750	1,293,000	1,309,750
Rail Planning - DOH	99,175	9,347,911	9,447,086
TOTAL	$209,757	$10,740,911	$10,950,668 1/

1/ The major portion is operational pass-through and Federal money for projects

H.B. 854 - Total Additional General Funds

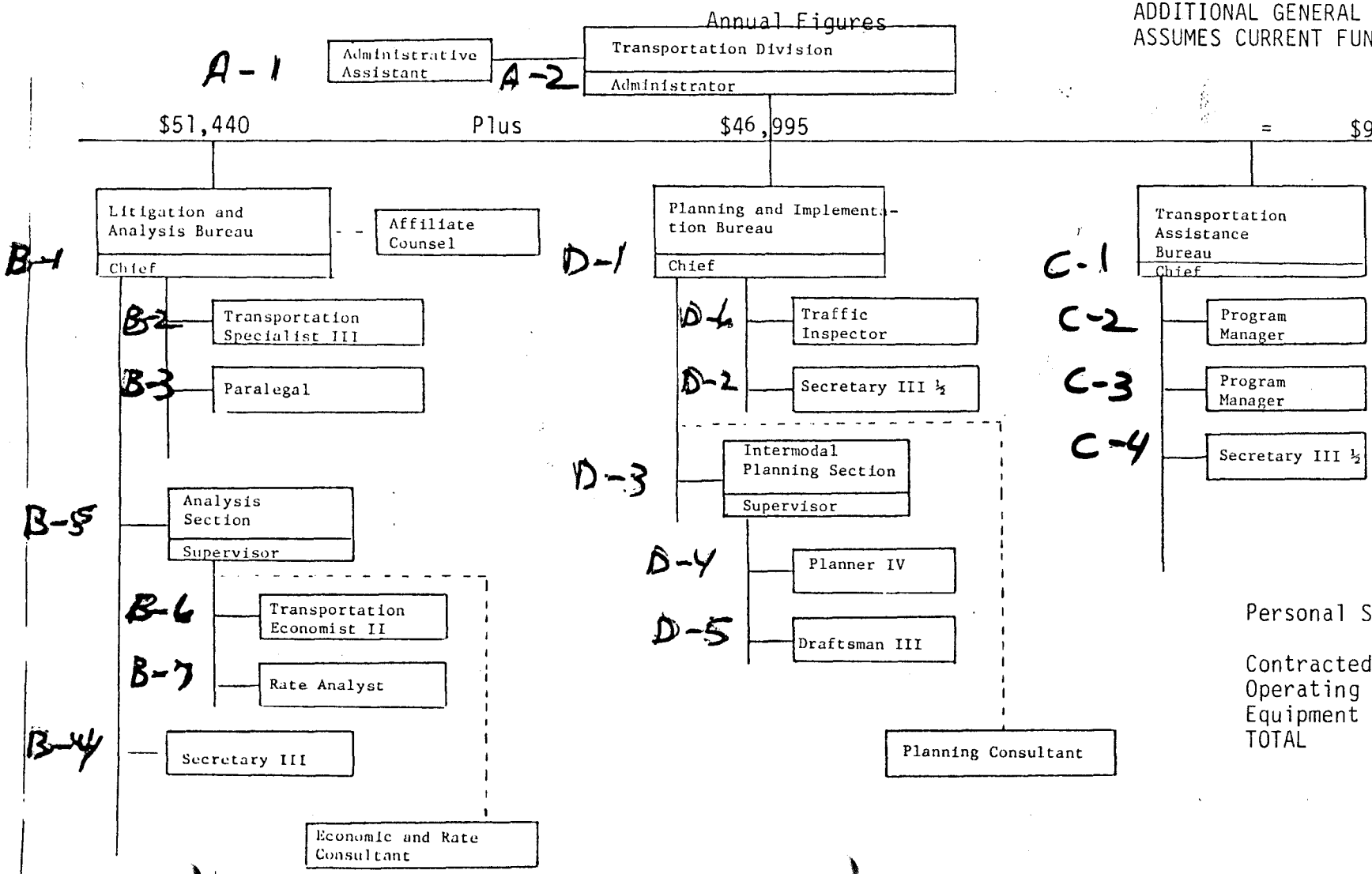
Division of Transportation - DOC--5 additional FTEs $324,626 2/

2/ The Montana House approved 5 new FTEs and additional general funds of $324,626

FY 82	$102,313
FY 83	222,313
TOTAL	$324,626

Annual Figures

ADDITIONAL GENERAL FUNDS ONLY
ASSUMES CURRENT FUNDING IN H.B. 500



Personal Services	$ 98,435
Contracted Services	
Operating Expenses	63,878
Equipment	
TOTAL	$162,313

STATE OF MONTANA

Office of the Legislative Fiscal Analyst

STATE CAPITOL
HELENA, MONTANA 59601
406/449-2986

~~JOHN D. LAFAVER~~
~~LEGISLATIVE FISCAL ANALYST~~

April 8, 1981

TO: Representative Chuck Cozzens
House of Representatives

FROM: Bob Robinson
Senior Fiscal Analyst

SUBJECT: Staff and Operating Budgets of State Agencies with Transportation Responsibilities

The table below summarizes the FTE and presents appropriations for state agencies that have responsibility in various transportation areas. The 1983 biennium operating appropriations for transportation related activity total $1,032,928 before pay plan adjustments. Federal railroad construction pass-through funds add another $8,838,547 not shown in the table.

		Fiscal 1982		Fiscal 1983	
FTE	Department	General Fund	Other	General Fund	Other
	Agriculture				
3	Transportation Unit*	$ 49,916	$ 50,000	$ 49,383	$ 50,000
	Commerce				
3	Rail Planning	60,119	224,900	39,056	279,554
4	Transit Assistance	8,000	104,000	8,429	109,571
10	Total	$118,035	$378,900	$ 96,868	$439,125
	Total Fiscal Year		$496,935		$535,993
	Total Biennium				$1,032,928

*The department of agriculture's transportation unit has 4 FTE budgeted for the 1983 biennium. One position has little to do with transportation and functions primarily as a marketing analyst for various agriculture products. The annual cost of this position is about $24,000. The fiscal 1982 and 1983 appropriations are net of this position.

Budgets for the above units for the 1980-81 biennium total $1,170,516. The proposed appropriations of $1,032,928 for the 1983 biennium represent an 11.8 percent decrease. Pay raises will add approximately $47,000 if the currentl proposed 8-5-5-5 pay plan is approved.

The table below compares biennial operating expenditure/appropriations for those transportation units.

	1980-81 Biennium	1982-83 Biennium	% Increase (Decrease)
Total Expenditures/Appropriations	$1,170,516	$1,032,928	(11.8)
Total With Pay Plan for 1983 Bienn.		1,079,928	(7.7)

RJR:ve:l

Testimony on House Bill 19

Submitted by TriCounty Retired Senior Volunteer Program Director (RSVP) Donna Eldrich, representing the RSVP Projects in Montana.

There are eleven (11) RSVP Projects in Montana which provide services to 44 communities. At this time there are 3,076 senior citizen volunteers providing service to 423 nonprofit organizations across the state. These volunteers contributed 458,528 hours of service to nonprofit organizations last year.

RSVP Projects provide the volunteers with transportation or mileage reimbursement, insurance and a noon time meal when they work over a lunch hour.

The RSVP Projects in Montana are funded by the Federal ACTION Agency for $233,235, these funds are matched with $121,318 local dollars. (70% federal, 30% local match) Local funding is provided by counties, cities, United Way and program generated funds.

I think the best way I can explain what RSVP does for the senior citizen volunteers and the communities where they serve is to use my project as an example and hope you will support House Bill 19. The appropriation is needed for transportation, meals and insurance for our volunteers.

Tri-County RSVP
Rocky Mountain Development Council
P. O. Box 721
Helena, Montana 59601

Room 108B Neighborhood Center
406-442-1552

The Retired Senior Volunteer Program (RSVP) is in its ninth year of operation. At present, three hundred twenty volunteers are assigned to fifty volunteer stations in the tri-county area. Thirty-five volunteer stations are tax supported agencies.

The major focus of RSVP is to provide meaningful volunteer opportunities to older Americans sixty years of age and over, while meeting the basic human needs of the community. RSVP volunteers are assigned to volunteer stations in hospitals, libraries, schools, nutrition programs, senior centers and other non-profit organizations. In addition to working with a variety of community agencies, RSVP sponsors a telephone reassurance program, a mailing group, a senior citizens' legislative committee, a volunteer attorney who gives free legal aid to senior citizens, an arts and crafts group and a singing group which performs in old fashioned costumes at various community activities.

RSVP staff encourage volunteers to become informed of and take part in the development of community services. RSVP volunteers contributed approximately thirty-eight thousand volunteer hours to organizations in Broadwater, Jefferson and Lewis and Clark Counties during the 1979/80 year.

RSVP is not designated a low income program; however, many volunteers would be unable to take part in the program unless transportation and mileage reimbursement was provided. RSVP also provides a noon time meal for volunteers who work through a meal time. All RSVP volunteers are insured.

A project director and coordinator of volunteers are responsible for the day-to-day operation of RSVP. A twelve member Advisory Council meets monthly to provide community input and program guidance. Four members represent the community, four represent volunteer stations, and four represent senior citizens.

RSVP is funded by an ACTION grant. Local funds are provided by Broadwater, Jefferson and Lewis and Clark Counties and United Way.

TRI-COUNTY RSVP
A UNITED WAY AGENCY

HB 19

"IT MEANS SO MUCH TO ME AT MY AGE TO BE ABLE TO HELP SOMEBODY."

That statement, made by an RSVP volunteer accurately reflects the purpose of the Retired Senior Volunteer Program which is concerned with the basic human needs of older Americans to remain active, to feel useful, and to continue participating as fully as possible in community life through volunteer service.

The Retired Senior Volunteer Program (RSVP) is a community service program specifically for persons 60 years of age and older. RSVP has two principle objectives:

-To provide people over 60 with personally satisfying opportunities to continue to involve themselves in community life; and to provide activities; and thus helping to improve the quality of life in the community as a whole.

There are eleven (11) RSVP projects in Montana. These projects involve some 3,000 volunteers who serve more than 400 organizations in 44 communities across the state.

During 1980, RSVP volunteers served more than 450,000 hours statewide. Averaging the value of this service at only $2.00 per hour, communities across the state received more than $900,000 worth of man-power support to civic activities.

The RSVP program is jointly supported by federal and local funds; a 70-30 match formula. In 1980 Montana received some $233,235 in federal funds. Via cash and in-kind, local communities contributed some $121,318 to support RSVP statewide as reported on grant applications.

Statewide the eleven RSVP projects experienced a 12% growth in volunteer numbers, and a 19% increase in number of communities served:

-Volunteer numbers:	1979 - 2,738	1980 - 3,076
-Communities served:	37	44

Based on an average value of $2.00 per hour for volunteer service, every local dollar invested in RSVP returned on the average $7.60 worth of community service. The actual total cost to supply one hour of volunteer service to a community averaged out at .82¢ per hour.

People are living longer and the community needs their knowledge and wisdon as much as they need us. We are beginning to recognize the many problems that are automatically created when there are thousands of people in every area of this country with nothing to do this last quarter of their lives. We DO need them and it must be our goal to reach each person that has the desire and ability to serve.

RSVP volunteers are "GIVERS" rather than just "RECEIVERS" of service, so they remain contributing members of society.

These older Americans are one of our nation's most precious natural resources. We request your support for HB 19.

R E T I R E D S E N I O R V O L U N T E E R

P R O G R A M

(RSVP)

ANNUAL REPORT

MONTANA

1980

V. PROJECT STAFF SUPPORT AND COSTS

Statewide the eleven (11) RSVP projects employ 21.65 staff positions. The average full-time equivalent staff salary was $8,897 in 1980. The staff to volunteer ratio was 1 to 140.

VI. GROWTH

During 1980 RSVP experienced a 12% growth in volunteer numbers, and a 19% increase in number of communities served:

	1979	1980
Volunteer Numbers	2,738	3,076
Communities Served	37	44

VII. VALUE RECEIVED BY LOCAL COMMUNITY

Based on an average value of $2.00/hour for volunteer service, every local dollar (cash/in-kind) invested in RSVP returned on the average $7.60 worth of community service. The actual total cost to supply one hour of volunteer service to a community averaged out at .82¢ per hour.

Federal Support	:	$233,235
Local Support/Grant	:	121,318
Estimated Unreported Support	:	20,000
Estimated Total Statewide Cost for 1980		$374,553
		Divided by
Hours Serviced in 1980		458,528
Average Cost per Hour Of Volunteer Service		81.7¢

VIII. POTENTIAL FUTURE EXPANSION

Based on actual inquiries, six (6) communities are interested in full-time, independent RSVP programs; and thirty (30) plus communities have indicated an interest in part-time, satellite projects. Expansion at these levels would require an additional $336,000 per year and yield an additional 2,250 volunteers:

I. PURPOSE

The Retired Senior Volunteer Program (RSVP) is a community service program specifically for persons 60 and older. RSVP has two principle objectives:

1. To provide people over 60 with personally satisfying opportunities to continue to involve themselves in community life; and

2. To provide man-power support to a broad cross-section of community activities; and thus helping to improve the quality of life in the community as a whole.

II. STATE COVERAGE

There are eleven (11) RSVP projects in Montana. These projects involve some 3,000 volunteers who serve more than 400 organizations in 44 communities across the state.

III. PROGRAM OUTPUT

During 1980, RSVP volunteers served more than 450,000 hours statewide. On the average each volunteer served almost 150 hours during 1980; more than three and one-half working weeks.

Averaging the value of this service at only $2.00/hour, communities across the state received more than $900,000 worth of man-power support to civic activities.

IV. FUNDING SUPPORT

The RSVP program is jointly supported by federal and local funds; a 70-30 match formula. In 1980 Montana received some $233,235 in federal funds.

Via cash and in-kind, local communities contributed some $121,318 to support RSVP Statewide as reported on grant applications. It is estimated that approximately $20,000 more was contributed, but not reported via grant applications. Sponsors are only obliged to report at least 30% match on grant applications.

Full-time Projects:	$21,000 X 6 =	$126,000
Part-time Projects:	7,000 X 30 =	210,000
Estimated Expansion Cost/Year		$336,000

Full-time Project: 175 Volunteers X 6 =	1,050
Part-time Projects: 40 Volunteers X 30 =	1,200
Estimated Increase in Volunteer Numbers	2,250

ATTACHMENT A

Retired Senior Volunteer Program (RSVP)
Annual Statistical Summary
MONTANA - 1980

Project Location	1 Annual Fed $ Support	2 Annual Local $ Support	3 # Of Staff On Project	4 Communities Served		5 Hours Served	6 Organizations Served - #	7 # Of Volunteers	8 Value of Volunteer Service to Community At $2.00/Hour	9 Ratio Of Value * Recieved By Community For Local To Project
BAKER	$ 15,305	$ 6,559	1.5	2	Baker Plevna	15,120	17	121	$ 30,240	1 to 4.6
Billings	28,134	26,025	2.6	6	Billings Ballantine Custer Huntley Worden Laurel	109,108	62	648	218,216	1 to 8.4
Bozeman	24,277	11,438	2.0	6	Bozeman Belgrade Gallatin Gateway Manhattan Three Forks W. Yellowstone	103,000	26	440	206,000	1 to 18.1
Glendive	17,918	8,489	2.0	2	Glendive Wibaux	19,522	31	140	39,044	1 to 4.6
Great Falls	24,365	10,442	2.75	3	Great Falls Cascade Simms	29,634	75	350	59,268	1 to 5.7

ATTACHMENT A

Retired Senior Volunteer Program (RSVP)
Annual Statistical Summary
MONTANA - 1980

Project Location	1 Annual Fed $ Support	2 Annual Local $ Support	3 # Of Staff On Project	4 Communities Served		5 Hours Served	6 Organizations Served - #	7 # Of Volunteers	8 Value of Volunteer Service to Community At $2.00/Hour	9 Ratio Of Value * Recieved By Community For Local To Project
HAVRE	$ 20,896	$ 8,956	1.5	6	Havre Gildford Hingham Inverness Kremlin Rudyard	36,616	21	295	$ 73,232	1 to 8.2
HELENA	22,400	9,600	2.0	6	Helena E. Helena Augusta Boulder Townsend Whitehall	39,000	50	396	78,000	1 to 8.2
KALISPELL	21,601	12,500	2.0	5	Kalispell Columbia Falls Whitefish Big Fork Somers	22,988	33	303	47,976	1 to 3.9

ATTACHMENT A

Retired Senior Volunteer Program (RSVP)
Annual Statistical Summary
MONTANA - 1980

Project Location	1 Annual Fed $ Support	2 Annual Local $ Support	3 # Of Staff On Project	4 Communities Served		5 Hours Served	6 Organizations Served - #	7 # Of Volunteers	8 Value of Volunteer Service to Community At $2.00/Hour	9 Ratio Of Value Recieved By Community For Local To Project
MISSOULA	$ 23,217	$ 9,951	4.5	1	Missoula County	26,118	61	206	$ 52,236	1 to 5.3
ROUNDUP	16,099	6,900	1.6	3	Roundup Musselshell Melstone	24,479	16	137	48,958	1 to 7.1
WOLF POINT	19,023	10,458	1.8	4	Wolf Point Bainville Froid Poplar	31,946	21	190	63,892	1 to 6.1

ATTACHMENT A

Retired Senior Volunteer Program (RSVP)
Annual Statistical Summary
MONTANA -- 1980

Project Location	1 Annual Fed $ Support	2 Annual Local $ Support	3 # Of Staff On Project	4 Communities Served	5 Hours Served	6 Organizations Served - #	7 # Of Volunteers	8 Value of Volunteer Service to Community At $2.00/Hour	9 Ratio Of Value Recieved By Community For Local To Project
MONTANA STATEWIDE SUMMARY	TOTAL STATEWIDE $ 233,235	TOTAL STATEWIDE $ 121,318	TOTAL STATEWIDE 21.65 Positions	TOTAL IN STATE 44	TOTAL 458,528	TOTAL STATEWIDE 423	TOTAL STATEWIDE 3,076	TOTAL STATEWIDE $ 917,062	STATEWIDE 1 to 7.6
	AVE/PROJ. $ 21,203	AVE/PROJECT $ 11,029	AVE/PROJECT 1.97 Positions	AVE/PROJECT 4	AVE/PROJ 41,685	AVE/PROJECT 39	AVE/PROJECT 280	AVERAGE/PROJECT $ 83,370	AVERAGE/PROJECT 1 to 7.6
					AVE/ Volunteer 149				

April 10, 1981

Senate Finance & Claims Committee
Capitol Building
Helena, Montana 59601

Testimony in Support of HB 568 - to appropriate general funds for gifted and talented children's programs ($200,000).

1) Dollar Value - Small funds can be used for maximum benefit. Not near the amount per child as for mentally handicapped is needed for these children, however some extra funds are needed for incentive. The return is startling and almost immediate.

2) Develop the resource already identified as fertile. It lies fallow in many schools.

3) Investigation shows these children do not always find for themselves as one would think. The cream does not always continue to rise. Boredom and lack of challenge and nurturing can lead to behavior problems and lack of will.

4) Funding for leadership and excellence has always been overshadowed by demands of many and varied groups whose needs appear more pressing. If some money exists, the time for the bright child has arrived. More than any other group of children they will show where a little money can go a long way.

5) When approached as a parent for our child to enter "a program for elementary students with outstanding intellectual abilities and demonstrated or potential academic achievement", we were hesitant and fearful. We were worried about overloading and peer group separation. We have been pleasantly surprised and excited with our daughters enthusisam and bubbling excitement about the program. After three years of participation, we are concerned regarding the termination of the program at the 6th grade level. We would not deprive our daughter of this experience for anything but lack of funds and programming are not now existent for a Junior High or High School program.

We would appreciate your considering funding for these children -- we would urge that the total monies be earmarked for programs for children rather than FTE, administrative, or indirect costs at the OPI level.

Thank you.

Merle & Shirley DeVoe

Merle and Shirley DeVoe
418 Butler
Helena, Montana 59601

Being bright is not always a blessing → to frustration, boredom — x no one looking where concepts are connected

4/

To: Montana State Senate Finance and Claims Committee
Senator Matt Himsl, Chairman

From: Gail Manninen
Kalispell, Montana

Date: April 11, 1981

Subject: Supportive Testimony for H.B. 568 - Appropriation Bill for Gifted/Talented Education

On behalf of Montana Association for Gifted and Talented Education (MAGTE) as their State President and on behalf of Kalispell School District #5 as their Gifted Program Coordinator, I strongly express our support for H.B. 568.

It should be recognized that the enabling legislation as cited in Chapter 7, Part 9 of the Revised Codes on Montana, 1979, and that the recommended appropriation bill currently before you has been thoroughly assessed by the sponsoring groups as it relates to the total educational system. The intent is not to label and fragment the structure of that system, but instead to assure each person that their educational potential will be developed as stated in Montana Law, Article X, Section 1. At the present time, due to the constraints of the regular education and special education programs, the needs of our gifted and talented youth are not adequately being met.

In addition, it is <u>not</u> the intent of the groups for which I speak that gifted programs <u>ever</u> receive full funding from the State level. Local dollar commitment is paramount for the development of effective programs, but initial development and growth monies are necessary from alternative sources.

To more effectively portray to you the importance and benefit of such programs, let me provide you with two sources of information:

1. A "Fact Sheet" on Kalispell's G/T Program which is exemplary in its scope, breadth of impact and cost/efficiency facior, and
2. Let me introduce to you Jean Monforton who is a parent and mentor with Kalispell's G/T Program can more specifically describe the need for such programs.

G/T PROGRAM

Kalispell School District #5

FACT SHEET

PROGRAM GOALS AND SERVICES

1. STUDENTS COMPONENT GOAL: The goal of the student component is to provide Program services which will result in the identification of gifted/talented students, enable the cooperative design of an eduaction plan uniquely suited to the individual students and guide the implementation of the plan.

   1.1. Number of students involved in Large Group Identification Procedure
   -Academic Year 1979-80 - 480 (Grades 4-6)
   -Academic Year 1980-81 - 852 (Grades 1-4)
   Number of students considered through Individual Referral Procedure (ongoing)
   -Academic Year 1980-81 - 62 (Grades K-7)

   1.2. Number of students placed in the G/T Program
   -Academic Year 1979-80 - 60 (7% of total student population - Grades 4-6)
   -Academic Year 1980-81 - 151 (11% of total student population - Grades 1-7)

   1.3. Percent of total student population impacted by G/T Program services and materials. (This information is based upon a random sample of teachers who have been utilizing G/T Program resources for a minimum of 3 months.)
   - 25% of the students are directly impacted by access to enrichment materials made available by G/T Program to the regular classroom. This involves approximately 298 students as of 3-25-81 in grades 3-7.
   -100% of the students are indirectly impacted as a result of G/T Program training to regular classroom teachers, use of resource people made available through G/T Program Resource Bank, and shared experiences of students participating in G/T Program activities. In grades 3-6, this means that 943 students have benefited from School District #5's G/T Program. In respect to a cost/efficiency factor, this means that for the local dollar commitment for the 1980-81 academic year (general fund - $44,250) the cost/student was $46.92.

2. PARENT COMPONENT GOAL: The goal of the parent component is to provide each parent of gifted/talented students with the opportunity to become an integral part of the learning environment for gifted/talented students in general and their children in particular.

   2.1. Parent Participation
   -In staffings (meetings held to determine the nature of student's placement in the G/T Program)
   with both parents 64%
   with one parent 36%
   with no parents 0%
   -Parent involvement in Junior Great Books Training - 10 parents
   -Parent meeting participation has involved - 130 parents

2.2. Volunteer Parent Support Services to Program Activities

Major Service Category	# of Parents Involved	# of Hours Spent	$ Value (@ $4.00/hr.)
Organizational Support (AGATE)	8	37	$148.00
Legislative Support:			
Leg. Committee Hearing	1	31	124.00
Local Contact Efforts	108	18	72.00
Transportation	40	85	340.00
Mileage (300 miles @ $.20/mile)			60.00
Miscellaneous Support Services	2	37	148.00
TOTAL:	159	208	$892.00

3. COMMUNITY COMPONENT GOAL: The goal of the community component is to facilitate the involvement of the community, inclusive of the educational community, as a resource to the gifted/talented learning process.

3.1. Resource Bank

-138 = number of community resource people identified by G/T Program for use by G/T Program and regular educational program.
- 41 = number of identified community resource people used to-date.

3.2. Volunteer Mentor Related Activities

Major Category	# of Events	# of Mentors (Community only)	# of Hours	$ Value (@ $10.00/hr.)
Creativity	11	9	94.5	$ 945.00
Science	10	10	71	710.00
Foreign Language	9	9	271	2,710.00
Self-Awareness	2	1	74	740.00
Language Arts	2	2	10	100.00
Social Studies	4	7	34	340.00
TOTAL:	38	38	554.5	$5,545.00

3.3. Miscellaneous Community Services

-10 community members participated in the Junior Great Books Training Session sponsored by G/T Program on March 10th and 11th.
- 5 other professionals were involved in the Junior Great Books Training Session
-The following FVCC staff members provided and facilitated the delivery of services to G/T Program students and parents: Dr. Zahrobsky, Donna Hopkins, and Lex Blood.

4. STAFF COMPONENT GOAL: The goal of the staff component is to enhance the efforts of teachers to recognize and meet the needs of the gifted/talented students in the regular classroom through inservice training.

4.1. Inservice Training
-25 primary teachers trained (completed 2-25-81)
-"Refresher" inservice session for intermediate teachers, 26 participants

4.2. Awareness Inservice Sessions
-70 KJHS and Linderman staff
-16 High School department chairmen and administrators

4.3. Junior Great Books Training Session - 15 staff involved

5. MANAGEMENT COMPONENT GOAL: The goal of the management component is to guide the operation of the Program through sound planning, coordination, evaluation and dissemination efforts.

5.1. Dissemination of materials and information about the G/T Program to 330 persons

5.2. Out-of-district visitors to the G/T Program - 10 persons

5.3. Number of formal presentations regarding the G/T Program - 6
-Number of persons reached - 288

5.4. Junior High Steering Committee involves 14 members including parents, teachers and administrators.

6. BUDGET SUMMARY 1980-81 Academic Year:

School District #5's General Fund	Supplementary Grants Received	In-Kind Volunteer Match $ Value
$44,250.00	$15,578.00	Mentor Related Activities - $5,545.00 Support Services 892.00 $6,437.00
Total 1980-81 Program Value - $66,265.00		

-Budget request for 1981-82 academic year to provide program services to grades 1-8 is $52,046.00.

-With the current number of 151 students placed in the G/T Program, this means that the projected program costs per student for the local district contribution is $344.68 for the 1981-82 academic year, or with 100% of all students being indirectly impacted by G/T Program services this equals $29.11/student in grades 1-8.
-The intent of the G/T Program is not only to serve the needs of the gifted/talented youth in our community, but to be a resource program to the total educational system.

-Furthermore, it is necessary to recognize when entertaining thoughts about "basic education", that one realizes that a G/T Program is basic education for our students of unusually high capabilities.

Submitted By: Gail Hammien
G/T Program Coordinator

To: Montana State Senate Finance and Claims Committee
Matt Himsl, Chairman
From: Jean Monforton, Kalispell Mt.
Date: April 11, 1981
Subject: Supportive testimony for HB 568

My viewpoint of the Kalispell Gifted and Talented program is a two-fold one: As a parent of 12 and 9 year old sons enrolled in the program, and as a French mentor to five students with whom I meet twice a week.

My observations from this dual viewpoint are that: First, these g. t. youngsters, through the design of this program, learn to accept and deal successfully with their exceptional talents. Prior to being enrolled, both of our sons experienced great frustration, for example, in being taught basic math facts that they had mastered at least two years before. For Matt and Jason, the easing of that frustration occurred through enrichment activities in math and twice-weekly sessions working with a computer. Illustrating, perhaps, that just as children of less-than-average mental ability often have trouble keeping up with their classmates, so children of above-average ability have trouble staying behind with their classmates.

Furthermore, the g.t. program gives these youngsters opportunities not even the most dedicated parents and teachers could provide single-handedly. Our 12 year old spent time with a broker in a local stock firm learning to find, read, and interpret basic information from indices and the firm's computer hook-up; and after doing research on his own, he bought 15 shares of common stock in a company of his choice, and last month, redeived his first dividend check.

Thirdly, I have observed that benefits spill over to peers and siblings, not directly involved, in the form of shared experiences, enthusiasm for learning, leadership, and inspiration.

Finally, with the g.t. program's support, parents have found community resources to help them to understand, to support, and to fully develop this invaluable natural resource that is their exceptional child. In short, to these unusually capable youngsters, a gifted and talented program is basic education.

Simply put, I think these youngsters are as dependent on us for the present as we are dependent on them for the future.

Thank you for your time.

OFFICE OF PUBLIC INSTRUCTION
STATE CAPITOL
HELENA, MONTANA 59601
(406) 449-3095

Ed Argenbright
Superintendent

April 11, 1981

To: Finance and Claims Committee

From: Ed Argenbright, Superintendent of Public Instruction
(Represented by Nancy Lukenbill, Consultant, Gifted & Talented Programs)

Re: House Bill 568

The constitution of the State of Montana states, "It is the goal of the people to establish a system of education which will develop the full educational potential of each person". Lawmakers and local school officials have done an admirable job in fulfilling the spirit of this constitutional goal. However, much is yet to be done if the citizens of Montana and the United States are to reap the benefits of our gifted and talented students.

Montana has 553 operating school districts which provide schooling to 155,072 students in 586 elementary, 23 junior highs and 169 high schools. Current projections estimate that 5% of these students are gifted and talented or about 7,700. At present, 32 school districts are providing programs to 1,300 gifted and talented students.

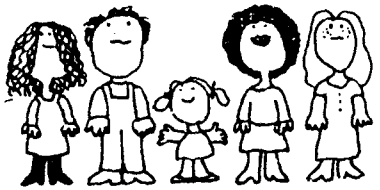
One measure of program success has been the use of the Ross Test of Higher Cognitive Processes, which is designed for gifted and talented students, grades 4 through 6 to assess higher level thinking skills. 477 students in 9 cooperating Montana school districts with gifted and talented programs were tested this year. A third party evaluation found the Montana results to be comparable with the publishers standards on higher level thinking skills.

The development of these programs have been the realization of concerned and energetic local school officials, teachers, parents, the Office of Public Instruction, legislators, and State organizations who have looked toward the future with the realization that without support for the gifted and talented child, a kaleidoscope of abilities may be wasted.

The activities of the Office of Public Instruction have included: parent and community awareness workshops, student evaluation and screening techniques, teacher inservice training and program development. We presently have requests from 20 additional school districts for assistance in studying options for providing programs to the gifted and talented.

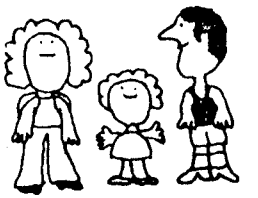
Once options and alternatives are identified, local districts will need assistance in teacher training, curriculum development, teaching strategies, selection and development of instructional materials.

House bill 568 will provide the financial support necessary to assist school officials in their quest to develop the potential of the state's gifted and talented young people. We respectfully request your support for this bill.



MONTANA 1980's

GIFTED and TALENTED PROGRAMS



School District Director	Description of Program	SCHOOL(s) and Grade Levels	Teachers
ALBERTON Wayne Peterson, Principal Alberton School Box 118 Alberton, Mt. 59820 722-4413	Academic Partial, Pull Out	Alberton School Grades 4-6	Tom Doohan Wayne Peterson Marlene Lodge
ANACONDA Robert Lemelin, Principal West School 1501 W. Park Anaconda, Mt. 59711 563-5562	Academic Part Time	West Elementary Grades 5 & 6	Will Menahan Sally Ralston Bob Monroe
BELGRADE Jan Rieboff Belgrade Elementary School 5 Southview Ave. Belgrade, Mt. 59714 388-1309	Academic Language Arts & Math ESEA IV C Incentive	Belgrade School Grades K-6	Janette Brownell Sally Peters Norma Gaffney Earlene Hemmer Jan Rieboff Jim Price Pam Takel Melody Hooper Liz Dunn Mary Andrews Dota Starkey
BELGRADE Mary Andrews Belgrade Junior High Box 166 Belgrade, Mt. 59714 388-1309	Academic Talents Unlimited Regular Class Teachers ESEA IV C Adoption	Belgrade K-8	
BIGFORK Joan Kubas Bigfork School Box 188 Bigfork, Mt. 59911 837-5271	Academic Partial Pull Out	Bigfork Elementary School Grades 4-8 A few students at grades 2 & 3	Joan Kubas

Georgia Rice, Superintendent
Office of Public Instruction
Helena, Mt. 59601

BR17180

1980 MONTANA STATE GIFTED PROGRAMS

School District Director	Description of Program	SCHOOL(s) and Grade Levels	Teachers
BILLINGS Charles Frank 101 10th St. W. Billings, Mt. 59101 259-0360 or 248-7421	Academic, Creative Thinking Partial Pull Out	Grades K-7 Arrowhead, Boulder, Poly Drive, Rimrock, Rosepark, North Park, Miles Ave., Central Heights, Broadwater, Eastern, Sandstone, Bench, Beartooth, Newman, Ponderosa, Meadowlark, Highland, McKinley, Garfield	Fran McDermott Vivian Scoles Julio Rukio Stephanie Hunt Ruth Tigges Marsha Putnam Kathy Kirkpatrick-- All Junior Highs
BOZEMAN Nina Willmuth Willson 5-6 404 W. Main Bozeman, Mt. 59715 586-8211	Academic	All Elementary Schools Grades 3 & 5	Nina Willmuth
BROWNING Marjorie Rink, Spec. Ser. Napi Elementary School Browning, Mt. 59417 388-2715, ex. 20	Academic & Creativity Partial, Pull Out	Napi Elementary School Grades 3-6	Marjorie Rink
BUTTE Rudy Shutey Butte School District 111 N. Montana St. Butte, Mt. 59701 792-8315	Academic Full-time Program	Emerson School Grades 5, 6 Butte High School Grades 10 East and West Junior High Schools, Grades 7, 8, 9	Lyla Held Donna Silverman Sheila Youngblood
CLINTON Ben Harrison, Superintendent Clinton School Clinton, Mt. 59825 825-3113	Will be based on children's interests Pull Out	Clinton Elementary School	Joyce Brown Nancy Bugbee

School District Director	Description of Program	SCHOOL(s) and Grade Levels	Teachers
COLSTRIP J. Pat Brunker, Principal Isabel Bills School 113 Box Elder Colstrip, Mt. 59313 748-2271	PROJECT E. T. C. Multi-Talents	Isabel Bills School Grades 3, 4, 5, 6, 7, 8	Sue Stewart, 3-6 Kay Plummer, Grades 7 & 8
GREAT FALLS Andrea Upshaw Bartelt, Dir. Washington School 1015 1st Ave. N. Great Falls, Mt. 59401 791-2276	PACE Project Academic, Creativity	Grades 4-6; half day per week Grades 8, and 8-9, one period per day. Senior High School-Independent	Sharon Patton Angie Nagengast Anita Ronning Kathy Rice
HAVRE Dr. Peck P. O. Box 791 Havre, Mt. 59501 265-4356	Thinking Process Academic	District #16 Elementary System Grades K-6	Peggy Wilcox (coordinates the classroom)
HELENA Karen Sexton Smith School 2320 5th Ave. Helena, Mt. 59601 442-8220	PROJECT PROMISE Academic, Intellectual Partial, Pull Out	Broadwater Bryant C. R. Anderson Four Georgians Hawthorne Jefferson Lincoln Ray Bjork Rossiter Smith	Karen Sexton Sue Fero Sharon Walker Rich Wirak
KALISPELL Gail Hanninen, Coordinator Lillian Peterson School 2nd West & Meridian Kalispell, Mt. 59901 257-7133	Enrichment Model Regular Classroom ESEA IV C Incentive	Grades 4-6 All District #5 Elementary	Regular classroom teachers
LAUREL Gordon Forester Elementary Supervisor 417 E. 6th Laurel, Mt. 59044 628-6916	TALENTS UNLIMITED Creative, Academic, Intellectual Regular Classroom	Fred W. Grass School West School South School Grades 1-6	All teachers

1980 MONTANA STATE GIFTED PROGRAMS

School District Director	Description of Program	SCHOOL(s) and Grade Levels	Teachers
LEWISTOWN James A. Longin Highland Park School 3112 7th Ave. N. Lewistown, Mt. 59457 538-3942	Academic & Creative Partial, Pull Out *Linus K. Yingst, Garfield School, 415 E. Blvd., 538-3288 Pat McGuire, Prin., Lewis & Clark School 212 Chrystal Drive, 538-8134	Highland Park School, grades 4-6 Garfield School, grades 4-6 Lewis & Clark School, 4-6 Junior High School, grades 7-8 Senior High School	Mary Chriswell--Lewis & Clark Margaret Latham--Garfield Colleen Knutson Highland Park Judy Byrne, Jr. Hi. Sid Wilson, Sr. Hi.
LIBBY Paul Stebbins Spec. Ed. Director Central Complex 111 E. Lincoln Libby, Mt. 59923 293-6204	LEEP (Libby Educational Enrichment Program) Enrichment (on Friday) in regular class. Topics are chosen and taught by community Volunteers who have expertise in the field. Topics: History, Energy, Writing, Journalism, etc.	Grades 1-7 Grades 7, two periods per day, emphasis on Language Arts	Regular classroom teachers Shirley Harryman--7th grade
LIVINGSTON Pat Boyer, Director Special Education 132 S. "B" Street Livingston, Mt. 59047 222-6600	Creative & Academic	Winans School East Side School Washington School Lincoln School grades 4,5	Catherine Lannan
LOLO Vic Jeppsen, Principal Lolo School Box 8 Lolo, Mt. 59847 273-6141	Academic Regular Classroom Teachers Summer program--2 weeks Enrichment--outdoor education, animal habitats and local history, depends on interest of students.	Lolo Elementary School K-8	Don Zundel Susan Harper Ed Woychiechowicz Gabrielle Prandoni Avis Welton
MILES CITY Don Gundlach, Principal Highland Park School 716 S. Cale Miles City, Mt. 59301 232-3890	Academic/Intellectual/Creative Partial, Pull Out One full day each week for grade level	Programs housed at Highland Park School, grades 2-4 and Lincoln School, grades 5-7 The program serves six elementary schools	Sharon Frickey Janette Gilligan
MISSOULA Chris Troxel/Elaine Capener Administration Building 215 S. 6th West Missoula, Mt. 59801 728-4000	PROJECT EXCEL Academic & Intellectual ESEA IV-C Innovative	Missoula School District #1 Grades 3, 4, 5, 6, Pull Out Program grades 1-2 and 7-8 Enrichment Program	Elaine Capener Raenelle Lees

1980 MONTANA STATE GIFTED PROGRAMS

School District Director	Description of Program	SCHOOL(s) and Grade Levels	Teachers
SIDNEY Frank Dahl, Principal Sidney Junior High School S. Central Ave. Sidney, Mt. 59270 482-4050	Academic	Sidney Junior High School Grades 7 & 8	Wayne Giese Laton Ziegler Vickie Smith Gary Arnold Mike Smith
STEVENSVILLE Ron Nicholas, Principal Stevensville High School 300 Park St. Stevensville, Mt. 59870 777-5481	Independent *Dale Dufresne	Stevensville High School	Sue Dolezol Sandi Hall John Parker Lana Denison
WOLF POINT Mike Preyer, Asst. Prin. Wolf Point High School 213 6th Ave. S. Wolf Point, Mt. 59201 653-1200	Academic Independent Study Projects	Wolf Point High School Grades 10, 11, 12	Undecided

1980 MONTANA STATE GIFTED PROGRAMS

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SIDNEY Frank Dahl, Principal Sidney Junior High School S. Central Ave. Sidney, Mt. 59270 482-4050	Academic	Sidney Junior High School Grades 7 & 8	Wayne Giese Laton Ziegler Vickie Smith Gary Arnold Mike Smith
STEVENSVILLE Ron Nicholas, Principal Stevensville High School 300 Park St. Stevensville, Mt. 59870 777-5481	Independent *Dale Dufresne	Stevensville High School	Sue Dolezol Sandi Hall John Parker Lana Denison
WOLF POINT Mike Preyer, Asst. Prin. Wolf Point High School 213 6th Ave. S. Wolf Point, Mt. 59201 653-1200	Academic Independent Study Projects	Wolf Point High School Grades 10, 11, 12	Undecided

Montana Office of Gifted & Talented--Minimum Grant Awards

Each of the following Districts were funded on a three year basis, contingent upon year end evaluation. Each District will submit a year end report, new objectives and budget for each year.

ol District Director	Description of Program	Funding Amount	Did School District Address Disadvantaged
e G. Peterson, Principal erton School--Joint strict #2 118 erton, Mt. 59820 -3381	To assist in the education development of 4, 5, 6, grade students in the area of problem solving, independent research projects, leadership and the ability to produce quality projects and assignments	$4,500.00	/X/ YES Indirectly--needs to elaborate / / NO
an Stewart, Teacher strip Public Schools #19 185 strip, Mt. 59323 -3191	To establish "Rosebud County G/T Coop" (southeastern Montana) services include: 1) materials and kits appropriate to G/T students in 8 districts. 2) Provide 12 in-service sessions to 8 districts for regular class teachers in identification and curriculum materials. Additional topics include: Identification, and curriculum for low income and culturally different. 3) Print monthly newsletter to 8 school districts.	$5,000.00	/X/ YES / / NO
t Hollenbeck chtown School #40 117 chtown, Mt. 59834 5222	1) Plan G/T program--year one 2) Develop in-service training for for teachers 3) Define academically and intellectually G/T students--grades 1-12	$4,968.00	/X/ YES Will also include inservice training / / NO
olph W. Jakes, Teacher na Flats #15 Helena Flats Road spell, Mt. 59901 2301	Lab-oriented enrichment program K-8 for approximately 27 students identified needs in areas of academics, artistic and performing arts	$1,854.00	/ / YES /X/ NO

Montana Office of Gifted & Talented--Minimum Grant Awards

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ol District Director	Description of Program	Funding Amount	Did School District Address Disadvantaged
e G. Peterson, Principal rton School--Joint strict #2 118 rton, Mt. 59820 -3381	To assist in the education development of 4, 5, 6, grade students in the area of problem solving, independent research projects, leadership and the ability to produce quality projects and assignments	$4,500.00	/X/ YES Indirectly--needs to elaborate / / NO
an Stewart, Teacher strip Public Schools #19 185 strip, Mt. 59323 -3191	To establish "Rosebud County G/T Coop" (southeastern Montana) services include: 1) materials and kits appropriate to G/T students in 8 districts. 2) Provide 12 in-service sessions to 8 districts for regular class teachers in identification and curriculum materials. Additional topics include: Identification, and curriculum for low income and culturally different. 3) Print monthly newsletter to 8 school districts.	$5,000.00	/X/ YES / / NO
t Hollenbeck chtown School #40 117 chtown, Mt. 59834 5222	1) Plan G/T program--year one 2) Develop in-service training for for teachers 3) Define academically and intellectually G/T students--grades 1-12	$4,968.00	/X/ YES Will also include inservice training / / NO
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Montana Office of Gifted & Talented--Minimum Grant Awards

Each of the following Districts were funded on a three year basis, contingent upon year end evaluation. Each District will submit a year end report, new objectives and budget for each year.

ol District Director	Description of Program	Funding Amount 1981-1982	Did School District Address Disadvantaged
illiam Harvey, Supt. n School--District #30 er R n, Mt. 59864 3390	Advanced academic program for grades 1-5. Half day program. Students select projects which compliment and expand the regular class curriculum but will include extensive investigation and study. Subject areas selected compliment the subject area of the students class work.	$5,000.00	/X/ YES Needs to develop an expanded process / / NO
. Brookins, Principal rior Elementary #3 400 rior, Mt. 59872 4962	Year one--Planning for G/T program development for approximately 25 students: Development of identification in procedures to include disadvantaged students. Develop in-service training for teachers and administrators	$5,000.00	/X/ YES Needs to be expanded with training in grant / / NO
er Anderson er Public Schools 40 er, Mt. 59542 2315	Year one--Develop framework for identification, information for staff on learning patterns, catalog materials for possible resources. Develop materials for Language Arts--grades 1-6. Identify students for program--in-service for staff.	$710.90	/X/ YES Addressed the disadvantaged statement but needs to develop in writing the full process. / / NO

PROPOSED AMENDMENTS TO HB 45

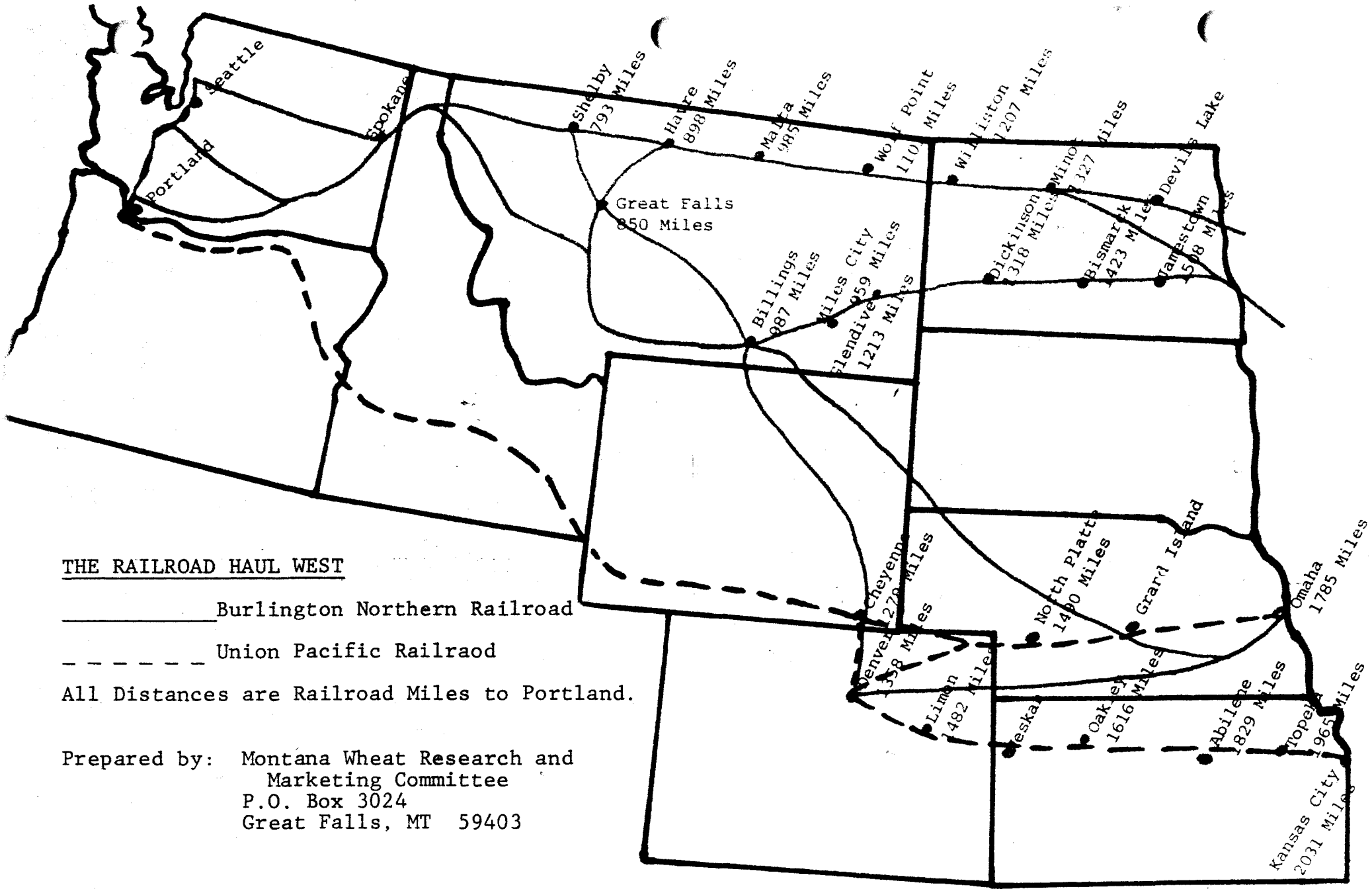
1. Page 44, line 6.
   Following: "retired"
   Insert: "on or after July 1, 1975, but"

2. Page 47, line 22.
   Following: "~~14~~%"
   Strike: "15%"
   Insert: "14.04%"

H. B. ~~19~~.

Add boiler plate ~~language~~ language that indicates such a grant is for research only and no indirect cost be taken out of it.

Be conc. as am.



THE RAILROAD HAUL WEST

_____ Burlington Northern Railroad

_ _ _ _ _ _ _ Union Pacific Railraod

All Distances are Railroad Miles to Portland.

Prepared by: Montana Wheat Research and
Marketing Committee
P.O. Box 3024
Great Falls, MT 59403

RAILROAD WHEAT FREIGHT RATES TO PORTLAND IN CENTS PER CWT - 2/18/81

CITY/ STATE	RR	SINGLE CAR	MULTI-CAR 2-4 ORIGINS	MULTI-CAR 1 ORIGIN	MAX-UNITS 1 ORIGIN
Abiline, KS	UP	178	(Not Available	(25) 158* 172**	(50) 148* 162**
Alliance, NE	BN	179	(27) 164	(27) 158	(54) 154
Billings, MT	BN	165	(26) 150	(26) 145	(52) 140
Bismarck, ND	BN	215	(26) 200	(26) 195	(52) 190
Denver, CO	DR&RG	150	(25) 132* 146**	(25) 132* 146**	(50) none 142½**
	UP	158			(50) 128* 142**
	BN	167		(27) 146	(54) 142
Devils Lake, ND	BN	215	(26) 200	(26) 195	(52) 190
Dickinson, ND	BN	215	(26) 200	(26) 195	(52) 170
Glendive, MT	BN	195	(26) 180	(26) 175	(52) 170
Grand Island, NE	UP	182	(25) 162* 176**	(25) 156* 170**	(50) 152* 166**
	BN	187	(27) 172	(27) 166	(54) 162
Great Falls, MT	BN	136	(26) 121	(26) 116	(52) 111
Havre, MT	BN	151	(26) 136	(26) 131	(52) 126
Jamestown, ND	BN	215	(26) 200	(26) 195	(52) 190
Kansas City, KS	UP	186	(25) 166* 180**	(25) 160* 174**	(50) 156* 170**
Lincoln, NE	BN	191	(27) 176	(27) 170	(54) 166
Minot, ND	BN	215	(26) 200	(26) 195	(52) 190
North Platte, NE	UP	178	(25) 158* 172**	(25) 152* 166**	(50) 148* 162**
Oakley, KS	UP	174	(Not Available)	(25) 154* 168**	(50) 144* 158**
Omaha, NE	UP	186	(25) 166* 180**	(25) 160* 174**	(50) 156* 170**
Shelby, MT	BN	145	(26) 130	(26) 125	(52) 120
Williston, ND	BN	200	(26) 185	(26) 180	(52) 175
Wolf Point, MT	BN	184	(26) 169	(26) 164	(52) 159

*SHIPPER OWNED CARS ** RAILROAD OWNED CARS

NOTE: All rates subject to a 1.2% and a 1.1% fuel surcharge. After Fe-ruary 20, 1981 an additional 1.2% fuel surcharge will be adde

LETTERS TO THE EDITOR

Cancer

From whence will come the cure for cancer? As a Bozeman physician, I am impressed by how much cancer there is in our community. No family in our area has not been tragically touched by cancer.

We doctors do very well at curing some cancers such as skin cancer. But we desperately, I say desperately, need a cure for most cancers such as lymphoma, lung cancer, stomach cancer and so on.

Unfortunately we are not close to finding a cure for cancer. And people continue to die.

From whence will come the cure for cancer then? It will come from brilliant thinking by a gifted researcher. It will come tomorrow from today's gifted child.

It will come from the type of person who invented the electric light, the taming of nuclear power, microelectronics, immunization, antibiotics, aseptic surgery, and coronary bypass surgery.

Is there a need to assist these gifted children in their education? Is there an urgency about it? Who cares? Perhaps people who have cancer should care. Perhaps people who may some day get cancer should care. Where does Montana stand on the issue of educating gifted children? Montana is almost at the bottom of the list.

Only North Dakota and South Dakota rank below us. Where does Bozeman stand on educating its gifted children? Well, we have had a gifted program in operation for a little less than a year.

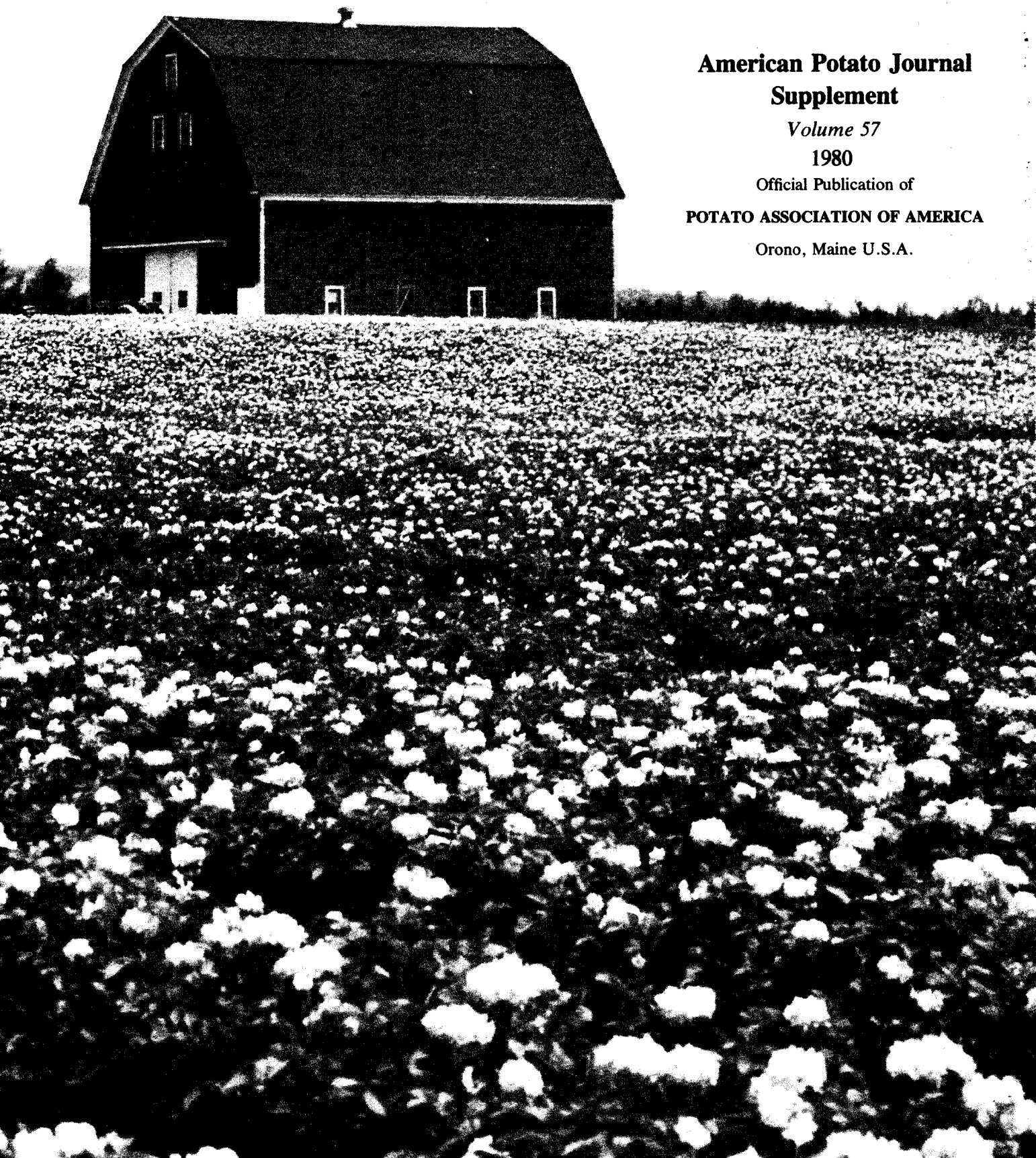
Tuesday night the school board cut it out completely. Well, it was not a unanimous vote. Two school board trustees voted to retain the gifted program. One was a doctor.

Do you understand why he wanted to continue the gifted program in Bozeman? Well, if you don't understand, ask your relative who has cancer. And people continue to die.

John R. Tkach, M.D.
Bozeman

Commercial Potato Production in North America

Potato Association of America Handbook



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1980

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Orono, Maine U.S.A.

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Commercial Potato Production in North America

Editors

Robert E. Thornton, Washington State University

Joseph B. Sieczka, Cornell University

POTATO ASSOCIATION OF AMERICA HANDBOOK
Supplement to Volume 57 of
The American Potato Journal

Revision of USDA Agricultural Handbook 267
By the Extension Committee of
The Potato Association of America

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INTRODUCTION

Commercial potato production is a complex and highly specialized commercial enterprise that demands a high degree of technical skill and practical experience on the part of the producer. With the trend toward increased processing use of potatoes since the middle 1950's, it has become necessary for growers to orient their production practices to the type of market in which they expect to sell. Nonetheless, these newer processing operations which manufacture chips, frozen, and dehydrated products provide important, large outlets which have reversed the declining per capita consumption of potatoes in the United States.

The continued application of farming technology has resulted in markedly less acreage required to produce more food. In the 1930's, between 3 and 3½ million acres of potatoes were harvested in the United States, but in the 1970's about 1.3 million acres produced 1½ times the tonnage produced 40 to 45 years ago (Table 1). Average yields of potatoes have increased steadily, and with further shifts westward to the high-yielding, irrigated fields of Washington and Oregon, the national average yield of this crop can be expected to reach 265-270 cwt per acre by 1985. Increased yields per acre have resulted from shifts in geographical areas of production, shifts to fewer but larger farms, marked changes in mechanization, and several improved cultural techniques.

In Canada, much the same trend exists with about one-half million acres of potatoes being planted in the 1930's and only one quarter million acres in the 1970's with about 25 percent more tonnage in the 1970's than in the 1930's (Table 2). Average yields have also increased in Canada by more than 2 times since the 1930's. Yield reported in Canada is substantially lower than in the U.S. because Canada's major production is from nonirrigated acres.

TABLE 1. — *United States acreage, yield and production of potatoes – Selected Years – 1930-1978.*

Year	Total Acres Harvested	Yield Per Harvested Acre	Production
	(1,000 Acres)	(cwt)	(1,000 cwt)
1930	3,139	66	206,290
1935	3,469	66	227,337
1940	2,832	80	226,152
1945	2,664	94	251,639
1950	1,698	153	259,112
1955	1,405	162	227,696
1960	1,386	185	257,104
1965	1,383	210	291,109
1970	1,421	229	325,752
1971	1,391	230	319,354
1972	1,254	236	295,955
1973	1,305	230	299,410
1974	1,386	246	341,097
1975	1,257	253	319,800
1976	1,375	260	357,674
1977	1,359	261	354,576
1978	1,368	263	360,467

Source: Crop Reporting Board, Economics, Statistics and Cooperatives Service USDA.

TABLE 2. — *Canadian acreage, yield and production of potatoes – selected years, 1935-1977.*

Year	Total Acres Harvested	Yield Per Harvested Acre	Production
	(1,000 Acres)	(cwt)	(1,000 cwt)
1935-39 (Avg.)	516	75	38,632
1951	285	105	29,928
1956	312	135	42,325
1961	306	144	44,108
1966	319	172	54,679
1970	316	176	55,123
1971	268	182	48,810
1972	244	180	43,886
1973	261	183	47,586
1974	283	195	55,146
1975	260	186	48,390
1976	263	196	51,585
1977	276	199	54,841

Source: Daviault, R. 1978. Selected Agricultural Statistics for Canada. Canada Agriculture Publication N. 78/10.

History

Most botanists agree that the potato originated in the New World, though the exact locality of origin is uncertain. Historians record that the Spaniards found potatoes in Peru at the time of their conquest of that country beginning in 1524. The native home of the potato is often claimed to be in the Andes of Peru and Bolivia at altitudes of 4,000 to 6,000 feet, where its very close botanical relatives flourish even today.

Historians disagree about the first introduction of the potato into Europe. There is good evidence, however, that the Spaniards introduced the potato from South America to Spain by 1580, or even as early as 1565. Hieronymous Cardan, a monk, is supposed to have been the first to introduce it from Peru to Spain. From Spain the plant was taken into Italy about 1585, into Belgium and Germany by 1587, into Austria by 1588, and into France soon after 1600. Philip de Sivry, Prefect of Mons, Belgium, sent two potato tubers to Carolus Clusius in Vienna, Austria, where they were received on January 26, 1588. Philip de Sivry had received a plant from an attaché of the Papal Legation; he, in turn, had obtained plants from Italy. De Sivry's colored drawing, now in the Plantin-Moretus Museum at Antwerp, Belgium, was probably made soon after 1588 and is considered by some writers to be the first European illustration made of the potato. However, the first published illustration and description was by Gerard, an English botanist. It appeared in 1597. Gerard, unfortunately, gave it the misleading name of *Batata virginiana*, and thereby created confusion as to the origin, history, and proper identification of the potato. The accepted botanical name *Solanum tuberosum* was first used in 1596 by the Swiss botanist, Kaspar Bauhin, and this was the name adopted in 1753 by Linnaeus in his Species Plantarum.

Introduction of the potato into England probably was independent of its spread in Europe. The exact time of importation into England is clouded by the confusion that existed among the potato, the sweet potato, and other tuber- and root-forming plants. In 1586, Sir Francis Drake introduced into England a plant that he incorrectly called potato. On this trip, Drake had stopped in Virginia and picked up survivors of Raleigh's Colony on Roanoke Island. Heriot, one of the colonists Drake brought back to England, later became farm manager of an estate in Ireland owned by Sir Walter Raleigh. However, the tubers or roots Heriot took back to England could not have been potatoes because none of his written descriptions of six root- or tuber-forming plants even approximates the potato.

It could very well be that the Spaniards first brought the crop to Ireland, because trade was brisk between Spain and Ireland in the 17th century. Without question, the newly introduced plant first became an important agricultural crop in Ireland. Soon after its introduction there, the potato was readily accepted as a staple food, demonstrating for the first time the potential commercial value of a plant that previously was no more than a botanical curiosity. Between 1650 and 1840 potatoes had become a vital part of the basic food supply in Ireland. When late blight disease wiped out the crop in the 1840's, famine forced many Irish people to emigrate to America. Because of its early food use and importance in Ireland, the potato plant is sometimes erroneously called the Irish potato.

When or where the potato was introduced into the continental United States is not known. It is believed that potatoes did not exist in Virginia when Drake landed there in 1586; if he had potatoes aboard his flagship, it is thought that they came from Cartagena (Colombia). One of the early colonial records shows that potatoes were ordered to be taken from England to South Carolina by colonists settling on the Edisto River in 1674. There is no record that potatoes were actually introduced at that time, however. Potatoes were introduced from Ireland into Londonderry, NH, in 1719, by a group of Presbyterian Irish. This is the first introduction into New England and possibly into the United States. Acceptance of potatoes as food was very slow in North America. However, total production had reached 1,603,730 hundredweight in 1840, when potatoes were first mentioned in the U.S. Census.

The potato industry in Canada dates back to 1623, when a small patch was grown at Port Royal (now Annapolis Royal) in Nova Scotia. The captain of an English trading ship had presented a barrel of potatoes to the early Acadian settlers, who used some of the potatoes for planting. From this humble beginning the potato has become one of the most important Canadian crops and is grown on more farms and in more gardens than any other food plant.

Botany of the Potato

The name "potato" is believed to have originated from the Indian name, "Batatas."

The potato is one of about 2,000 species in the family Solanaceae. This family includes such plants as tobacco, tomato, eggplant, pepper, horse nettle, bittersweet, ground cherry, and petunia. Botanically, the potato cultivated in North America, Europe, and other lands is *Solanum tuberosum* L. There are nearly 160 wild species and 20 cultivated species of the tuber-bearing Solanums. All these relatives of the potato are of New World origin. Probably the closest wild relative is *S. andigenum* Juz. & Buk, which produces acceptable yields under the short-day conditions of the Andes Mountains. Most botanists now consider *S. andigenum* to be a subspecies of *S. tuberosum*.

The potato may be classified as a dicotyledonous annual, although it can persist in the field vegetatively (as tubers) from one season to the next. In fact, volunteer plants growing from unharvested potato tubers, unintentionally left in the field, create many problems in pest management that affect the production of certified seed as well as that of commercial potatoes.

Being a dicotyledonous plant, the potato has the characteristics of all dicotyledons including stems with vascular bundles placed in a circular arrangement and containing definite layers of xylem and phloem. The potato may be grafted within the species *Solanum tuberosum* as well as upon related species. Frequently one reads of tomatoes being grafted upon potato root stocks to obtain plants bearing tomatoes on the tops and potatoes underground. Such plants have no commercial value. Some potato breeders have grafted varieties of potatoes upon tomato stocks (or vice versa) to induce better flowering and seed setting and for disease studies.

Morphology and Anatomy

The potato tuber is an enlarged portion of an underground branch of a stem called a stolon or rhizome (Fig. 1). Technically, these underground stems of the potato most nearly approximate rhizomes, but the term stolon is more common. The stolons have leaf scales located alternately on their surface in the same manner as the above ground stems. The tubers originate from the tips of stolons, and occasionally tubers form along the stolon itself. The potato tubers contain all the characteristics of normal stems, including dormant true buds (eyes) formed at the base of a leaf (rudimentary in this case) with detectable leaf scars (the eyebrows). Lenticels or stem pores through which air penetrates to the stem interior are plainly found on most tubers. Lenticels often become enlarged to objectionable size when soils are overly wet and access of air is restricted.

The buds (eyes), from which comes further growth are found in a spiral pattern on the tuber. The eyes tend to be concentrated at the seed or apical end of the tuber. They are fewer in number and farther apart toward the stem end where the tuber is attached to the stolon.

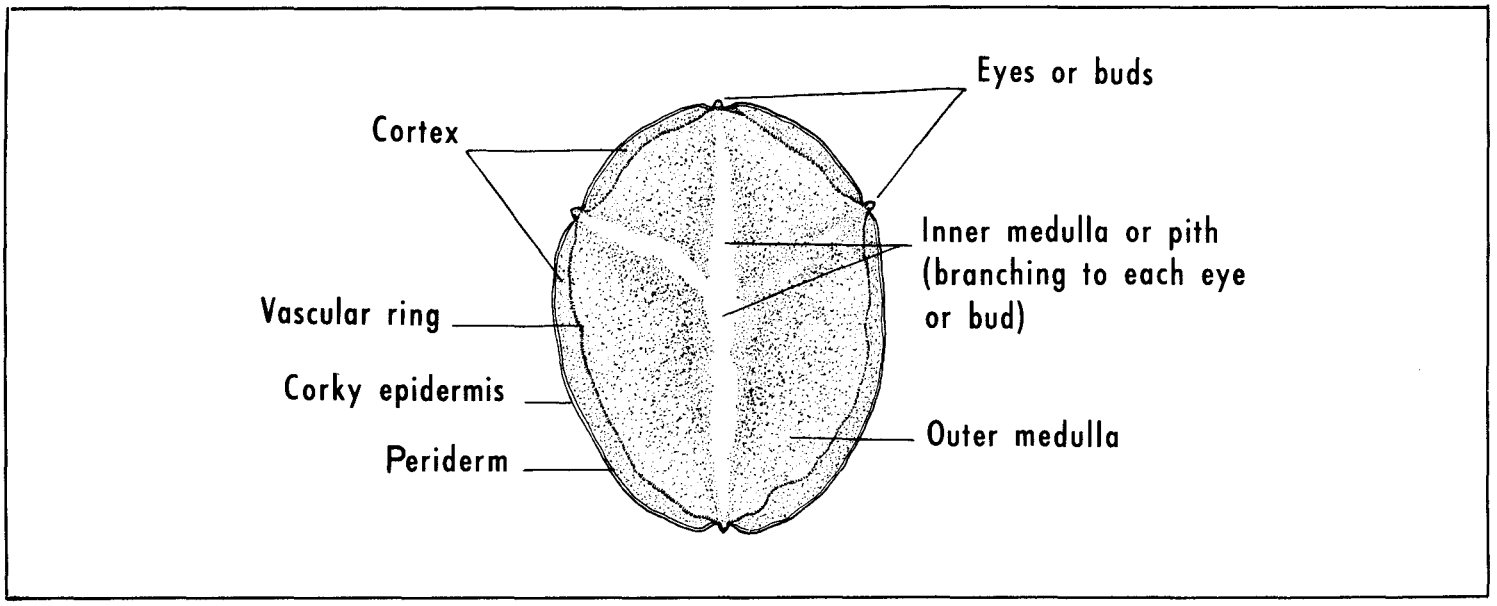

Fig. 1. Cross section of a potato tuber. The water-soaked appearance of the inner medulla is normal though it may be more pronounced in some tubers than in others.

The buds (eyes) of the seed end possess apical dominance and will normally sprout first, a condition characteristic of buds at or near the apex of all conventional stems. When the apical buds are removed, or die, other buds are stimulated to sprout in the same manner as lateral buds on a woody stem are stimulated to sprout when the "leader" is removed. When whole tubers are planted, the effect of apical dominance is especially important because with whole seed only one to three large productive stems per hill will usually emerge. The effect of apical dominance is reduced if a large tuber is cut into smaller seed pieces. Stems from cut seed pieces tend toward greater uniformity in rate of emergence, but a noticeable difference will still exist between stem-end and seed-end sprouts.

The outer layer of single cells of the tuber, the epidermis, is usually colorless. Anthocyanin, the pigment that colors red and blue potatoes, is found in the periderm (several layers of corky cells immediately below the epidermis). The corky epidermis and periderm together comprise the "skin" of the mature tuber (Fig. 1). The varieties Norland, Chieftain, Red McClure, Pontiac, and Viking are commercial varieties with red pigment (anthocyanin) in the periderm. In a few varieties the colored pigment is in the outer layers of the cortex, the region immediately inside the periderm that extends inwardly to the vascular ring. Varieties known to have red pigment in the outer cortex are Spaulding Rose, Early Rose, and Early Ohio.

The remainder of the tuber from the vascular ring inward, designated as the medullary area, is divided into outer and inner medulla and constitutes the fleshy part of the tuber. The outer medulla generally contains the denser portion of this area; the inner medulla includes the watery and more translucent part. Persons unfamiliar with the internal structure of the potato sometimes mistake the inner medulla for an abnormality or defect. The inner medulla extends toward each eye, forming a continuous tissue that connects all the eyes of the tuber (Fig. 1).

The initiation of young tubers at the tips of the stolons usually occurs when the plants are 6 to 8 inches high, or from 5 to 7 weeks after planting (Fig. 2). Tuberization is affected by many environmental factors and depends largely on translocation and storage of food in excess of that needed by other parts of the plant in its growth and metabolism. Growth of the young tuber is the result of both cell division and elongation and storage of translocated food constituents within the cells.

Contrary to a commonly accepted notion, tuberization is not dependent upon flowering. Potato plants will form tubers without any flowers ever appearing on the tops. Some researchers have even conversely suggested that tuberization is actually enhanced by removing the flowers or flower buds. The notion that tuberization depends on flowering arose because unfavorable climate such as hot and dry growing conditions, which are normally unfavorable for flowering, also retard or even inhibit tuber formation. Because climatic conditions that favor flowering also favor tuberization, it seems natural to make the mistake of associating flowering with high yields and poor flowering with low yields.

Plant Introduction and Maintenance

For a long period after the potato was introduced into North America, little effort was made to improve it or to introduce new kinds. Thus, the period from 1719 to 1850 was characterized by no marked or lasting improvement in the crop. Improvement of potatoes near the end of this period became imperative because the available varieties "ran out" to the extent that yields decreased to low levels and production was uneconomical. "Running out" was caused largely by high levels of tuber-transmitted virus diseases in existing stocks and lack of proper seed maintenance methods.

In 1851, C.E. Goodrich, a clergyman of Utica, NY, introduced a small amount of potatoes received from the American consulate in Panama. A selection called Garnet Chili resulted from this introduction. Nearly 200 named potato varieties, including several important commercial ones still grown, have this single variety represented in their ancestry.

Since 1925, several plant explorers have made plant exploration trips into Mexico, Central America, South America, and other

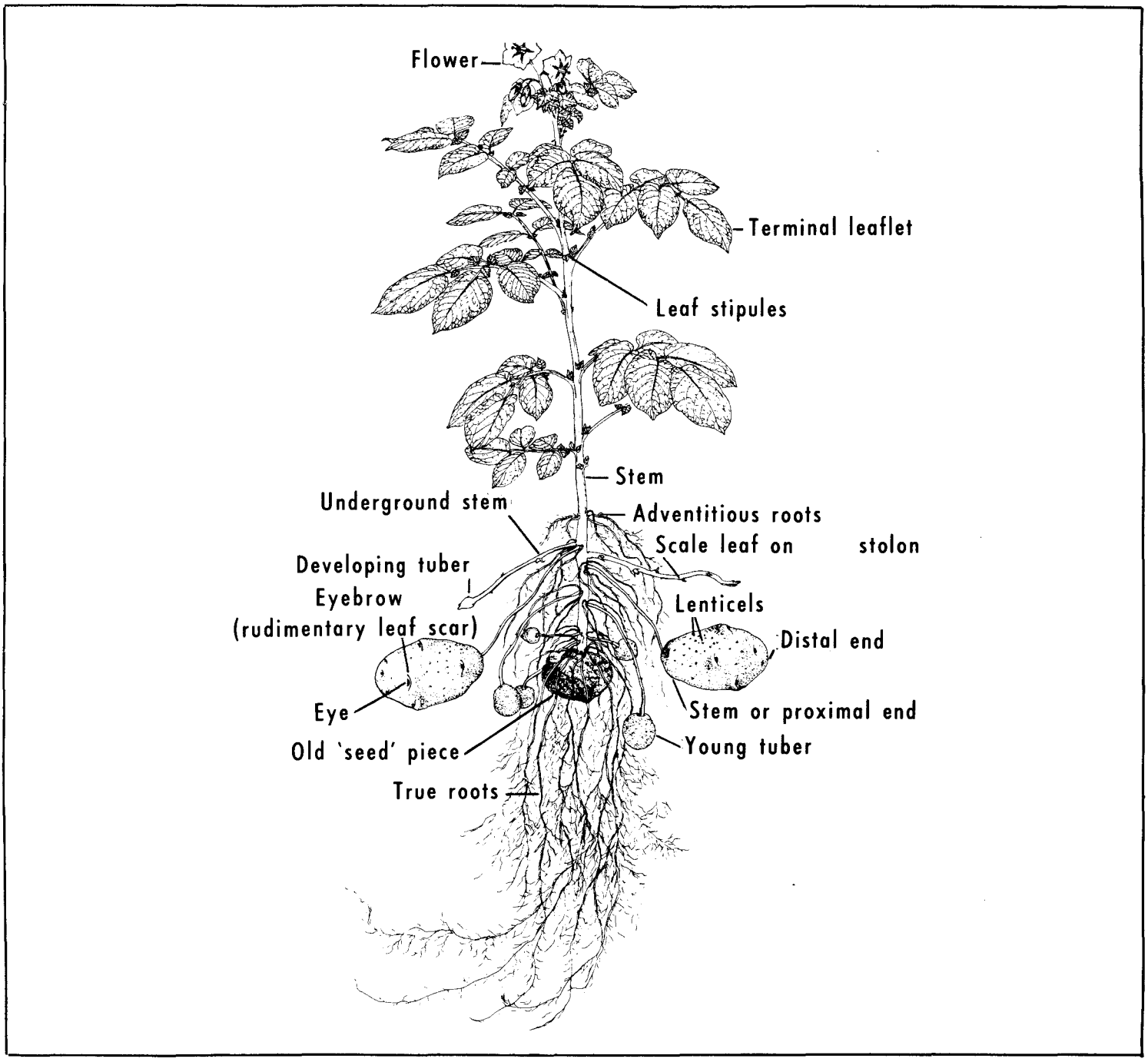

Fig. 2. Diagrammatic drawing of a potato plant. Note that tubers are formed on stolons and that stolons differ from roots.

areas where the potato is believed to have originated, in search of new forms of the potato for use in improving commercial types. In addition, many named varieties of potato have been introduced into North America from most of the potato-producing areas of the world. The continual flow of new material coming into the U.S. is coordinated by the New Crops Research Branch of the Science and Education Service in the U.S. Department of Agriculture. New material coming into Canada is handled by the Plant Quarantine Division of the Ministry of Agriculture.

The most challenging problem following the introduction of foreign potato varieties is the maintenance of the collection in a vigorous, disease-free and insect-free condition. Most of the introductions must be propagated and maintained vegetatively because they do not reproduce or breed true to their original type when grown from true seed, and many produce few, if any, true seeds under normal conditions of culture. Vegetative propagation is the only sure means of maintaining unchanged original lines that possess important characteristics that otherwise might be lost. This vegetative method of propagation necessitates planting and growing the many introductions each year — a time-consuming and expensive process, which also exposes the plants to the continual danger of infection with tuber-borne diseases.

To help solve these problems and maintain the valuable characteristics of foreign plant introductions, a special potato introduction and maintenance station was established by the U.S. Department of Agriculture and cooperating State agricultural experiment stations. At this station, located at Sturgeon Bay, WI, all introductions of the tuber-bearing *Solanum* species, valuable parental stocks, and varieties are maintained as true seed or tubers. In Canada a similar program is located at the Agriculture Canada Research Station at Fredericton, New Brunswick.

Per Capita Consumption of Potatoes

Not all the potatoes produced on the North American Continent each year are used for food. The United States seed requirements take about 7 percent of output; often substantial quantities are fed to livestock or shrink in storage. In recent years, food use has accounted for about 83 percent of production. In Canada potatoes are used primarily for human consumption although some are produced for certified seed and for livestock feed.

Considering food use in the United States only, potato consumption in this country formerly was much larger, having decreased from 198 lbs. (89.8 kg) per capita in 1910 to 103 lbs. (46.7 kg) in 1956 (Table 3). There was a steady decline in potato food use from 1910 to the middle 1950's as the American diet expanded. Potatoes had been a major staple of the American diet, but as more foods were introduced as personal incomes rose, people's tastes broadened. Also, the quantity and variety of fresh and processed vegetables were much more limited 50 years ago, while potatoes were available throughout the year in most sections of the United States.

TABLE 3. — *U.S. per capita consumption of potatoes.*

Year	Tot. Fresh & Proc.	Fresh	Processed[1]				
			Total	Canned	Frozen	Shoestring & Chips	Dehydrated
			Pounds				
1956	102.7	88.0	14.7	1.3	2.9	8.9	1.6
1957	109.3	98.2	16.0	1.5	2.9	9.6	2.0
1958	104.7	86.8	17.9	1.6	3.5	10.1	2.7
1959	106.7	85.5	21.2	1.5	4.9	11.0	3.8
1960	108.4	83.8	24.6	1.5	6.6	11.6	4.9
1961	109.3	83.8	25.5	1.5	6.8	12.3	4.9
1962	107.3	78.4	28.9	1.6	9.4	13.1	4.8
1963	111.4	79.9	31.5	1.7	11.0	13.9	4.9
1964	111.0	74.6	36.4	1.7	14.6	14.8	5.3
1965	107.0	68.2	38.8	1.7	14.3	15.8	7.0
1966	116.8	72.4	44.4	1.7	17.3	16.7	8.7
1967	108.0	62.0	46.0	1.7	19.0	16.9	8.4
1968	115.2	65.9	49.3	1.9	21.2	17.1	9.1
1969	116.9	61.7	55.2	2.0	24.6	17.7	10.9
1970	117.5	58.3	59.2	2.0	27.7	17.7	11.8
1971	118.7	56.8	61.9	2.2	30.3	17.3	12.1
1972	119.4	57.4	62.0	2.1	30.6	17.0	12.3
1973	116.8	51.9	64.9	2.3	33.2	16.6	12.8
1974	114.3	48.4	65.9	2.3	33.0	16.1	14.5
1975	122.1	55.0	67.1	2.0	34.7	15.9	14.5
1976	116.4	51.2	65.2	2.0	36.9	16.2	10.1
1977[2]	121.7	54.0	67.7	2.5	39.9	16.0	9.3

[1]Revised to include potatoes canned in soups, stews, etc.
[2]Preliminary
Source: Crop Reporting Board, Economics, Statistics and Cooperatives Service USDA.

During the 1950's, however, this trend reversed itself as more processed potato products were introduced to the American diet. Annual per capita consumption (fresh and processed combined on a fresh weight equivalent basis) rose from 103 lbs. (46.7 kg) in 1956 to 122 (55.3 kg) in 1975.

This rise was entirely due to gains in processed use, which moved from 25 lbs. (11.3 kg) in 1960 to 68 lbs. (30.8 kg) in 1977. Fresh use has continued to decline. Of processed consumption, frozen potatoes, mostly french fries, made the greatest gain during the 1960's increasing from 7 lbs. (3.2 kg) in 1960 to 40 lbs. (18.1 kg) in 1977. This can be attributed primarily to the commercial and fast-food businesses which have been steadily increasing their use of this product. Although frozen potatoes increased the most, chips and dehydrated potatoes posted gains also (see Table 3). The potato chip industry made its greatest market growth during the early 1960's. Beginning about 1970, sharp gains were noted in dehydrated potato use. Further gains are expected for flakes and granules.

In Canada, the average annual consumption per capita has also declined from a per capita consumption of 193 lbs. (87.5 kg) in the early 1900's to around 150 lbs. (68 kg) per capita in the 1970's (Table 4). Many of the same reasons for changing per capita consumption in the U.S. are true for Canada. Although a decline in consumption in Canada occurred, it did not go as low as it did in the U.S. and is currently at a considerably higher level than it is in the United States. In the early 1960's consumption was near 140 lbs. (63.5 kg) per capita and in one year's time (1966-1967) increased by nearly 30 lbs. (13.7 kg) per capita to 174 lbs. (78.9 kg). But a trend of reduced consumption has followed.

TABLE 4. — *Canadian per capita consumption of potatoes.*

Year	Total Fresh and Processed
	Pounds
1935-39 (Avg.)	192.3
1949	159.0
1951	143.0
1956	153.3
1961	147.5
1966	141.3
1967	173.5
1968	151.7
1969	169.9
1970	152.9
1971	161.3
1972	162.1
1973	153.9
1974	146.8
1975	154.4
1976	139.1

Source: Daviault, R. 1978. Selected Agricultural Statistics for Canada. Canada Agriculture Publication No. 78/10.

The Potato as Food

The potato has been responsible for the survival of millions during the last three centuries. For many people—from South America to Europe—daily pounds of potatoes, supplemented with small amounts of milk, meat, and fish, have been the cornerstone of a life-giving diet. But few people are aware of how important a contribution relatively small amounts of potatoes still make to nutrition today.

The key to this contribution is what modern nutritionists call the high "nutrient density" of the potato. This means simply that, for each ounce of potato eaten, there is an ample return of essential nutritional values.

To see the potato as nutritionists see it, consider that the average U.S. daily per capita consumption of potatoes contributes only a little more than 100 calories a day, or about four to five percent of the calories in most adults' total daily food. Yet, this small amount of potatoes (roughly equal to a potato about 2.5 inches (6.4 cm) in diameter) furnishes at least 65 percent of the U.S. Federal daily recommendation for vitamin C. If we had no vitamin C except for that from potatoes, on a per capita basis, there would be no sign of scurvy (vitamin C deficiency disease) in North America simply from the eating of the daily per capita consumption of potatoes.

At least 12 essential vitamins and minerals are furnished by potatoes but none equal the extreme density of vitamin C. In addition, potatoes contain protein in amounts greater than or equal to its percentage contribution to our calories. The nutrient density of potatoes of two sizes: "medium," 2.5 inches (6.4 cm) in diameter, three to a pound; and "large," 2.25 inches (5.7 cm) in diameter and 4.75 inches (12.1 cm) long, two per pound is given in Table 5. Because the data are from a new study, which awaits further crop and storage information, it is still preliminary. So, ranges from the lowest to the highest average values are shown. Final figures are expected to fall between the ranges shown.

TABLE 5. — *The nutrient density of potatoes*.*

Values, except for calories, are shown in percentages of the U.S. Recommended Daily Allowances, U.S. RDA, est. 1973.

Nutritional Values		Percentage U.S. RDA in "Medium" Potato (about 150 g)	Percentage U.S. RDA in "Large" Potato (about 250 g)
Calories		About 110 Approx. 4% of total calories, adult male)	About 180 (Approx. 7% of total calories adult male)
Vitamin C	13.21 - 54.15 mg**	56.6%***	93.3%***
Iodine	0.0512 - 0.0423 mg	15.2%	25.3%
Vitamin B_6	0.188 - 0.597 mg	16.4%	27.3%
Niacin	0.96 - 3.84 mg	12.1%	20.2%
Copper	0.130 - 0.491 mg	16.9%	28.2%
Magnesium	0.0254 - 0.0381 g	7.8%	13.0%
Thiamin (B_1)	0.067 - 0.153 mg	8.7%	14.5%
Phosphorus	0.0467 - 0.0980 g	7.3%	12.2%
Protein	2.48 - 3.62 g	4.7%	7.8%
Folic Acid	7.82 - 32.51 mcg	4.9%	8.2%
Iron	0.4130 - 2.106 mg	5.2%	8.7%
Riboflavin (B_2)	0.0315 - 0.1326 mg	3.6%	6.0%
Zinc	0.492 - 0.801 mg	3.9%	6.5%

*Nutritional values selected are those for which averages are expected to show a percentage of U.S. RDA equal to or greater than the percentage of calories provided by a "medium" potato. Data are taken from a 1975-76 study sponsored by The Potato Board and conducted by the University of Idaho (Dr. Jorg Augustin), The University of Maine (Dr. John Hogan and Ruth True), and the U.S.D.A. Red River Valley Research Center (Dr. Roy Shaw and Dr. R. Toma).

**Ranges are due to variations in values due to storage time (0-10 months) and to varietal differences.

***Data are averages after weighing the influence of varieties and storage time.

Why Is the Nutrient Density of Potatoes Important?

A key problem of nutrition is that the need for calories is down at least a third from that required in 1900. Our physical activity is lower. Yet, we need much the same nutrition from our lessened food intake.

So, unless we eat nutrient-dense foods, we consume too many calories in getting adequate nutrition, a main reason for obesity. Or we may control calories, but get too few nutrients, a common situation among the people of North America.

For example, iron is low in the diets of many children, of younger women, and the elderly. The potato is not rich in iron; few foods are. Yet consider that potatoes, at the U.S. level of per capita consumption, supply only two weeks of our average annual need for calories, but furnish the iron for almost a month out of the year.

Similarly, folic acid is low in many diets, especially among pregnant women, and it is scarce in foods. Potatoes supply about a month's requirement for folic acid, per capita, each year.

Many of us are short of vitamin B_6. Potatoes furnish about a month and a half's recommendation for this vitamin. They offer even more of our thiamin, another marginal vitamin, and probably a still larger part of our copper. Through such comparisons of calories to nutrients, one can see why nutrient-dense foods are being recommended to the public by nutritionists.

POTATOES AND THE NEW BALANCE OF THE DIET—Recent concern about diet and heart disease has alerted us to the high intake of fats — perhaps supplying 45% of our calories and more. Unsuspected by many, this increase is often associated with efforts to eat more protein. Many people do not realize that fat tends to be high in "high-protein" foods.

While the effect of diet on heart disease is still unclear, nutritionists have other reasons to suggest lowering fat consumption and eating more carbohydrate foods. One reason is that fats have more than twice as many calories as do carbohydrates. So many carbohydrate foods have higher nutrient density.

This higher density is not true of *all* such foods. For example, sweeteners—such as table sugar, honey, corn syrup—are carbohydrates, but have few other nutrients, if any. Thus, balancing the diet has come to mean cutting back on proteins, fats, and sweeteners and increasing nutrient-dense carbohydrates.

POTATOES AND THE NUTRITION FUTURE—Trends in nutrition science tend to be slow to reach the public. But nutritionists' interest in nutrient-dense foods which have wide acceptance and low price suggests a renewed appreciation of potatoes. The market has already reflected some of this change.

Studies indicate that many people have overcome old, unscientific prejudices that potatoes are especially caloric, hence, especially fattening. As new analyses explain how potatoes supported life in other, older cultures, as more people learn that they need no more protein and that eating much fat tends to mean poor nutrition in a society that spends little body energy, the nutrient-dense potato, a nutritional staple of the past, becomes more and more a food of the future.

POTATOES IN A HUNGRY WORLD—Besides being an important nutrient-dense food, the potato is an efficient producer of food energy and nutrition per acre and must figure prominently in combatting any world food crises. Recent data indicate that potatoes produce 74.5% more food energy per acre than wheat and 58% more than rice. Also, potatoes produce 54% more protein per acre than wheat and 77.6% more than rice. In fact, no other food can match the potato in its production of food energy and food value per acre.

PRODUCTION AREAS

Production Areas in the United States

Potatoes are grown commercially in every state in the United States (Fig. 3). There is not a single month in the year when potatoes are not being planted or harvested somewhere. While this is true, fall production continues to account for an increasingly larger share of U.S. output, moving from 74 percent of the 1965 crop to 78 percent of the 1970 crop and 85 percent of the 1975 crop. This increase has come at least partly at the expense of the summer and spring crop production areas. Production during the summer and spring seasons accounted for about 14 percent of the 1975 output divided equally between the two seasons. Winter production in Florida and California accounted for the remaining one percent. Agronomic and economic reasons are responsible for the continued shift to fall producing regions. In some of the areas of increasing production, potatoes are one of the most profitable crop alternatives for farmers, especially in areas where the growing season is relatively short. Improved storage technology has lengthened the marketing season of the late producing areas allowing them to market fall-grown potatoes throughout the year. Spring and summer potatoes have been less suitable for storage, therefore, the producers in these areas have not been able to market a large volume by extending their marketing season.

While fall potato producing areas have become more important, there has been a significant westward production shift taking place at the same time. In 1965, 47 percent of the U.S. fall output came from the Western states (Rocky Mountain and Pacific Coast) combined. In 1970, the comparable figure was 54 percent. And in 1975, 62 percent of the U.S. fall crop came from the Western region. At the same time, production of potatoes along the Atlantic Seaboard declined substantially. Idaho is the leading state in total production, followed by Washington which has made sharp gains in recent years. Oregon is third and Maine is fourth. These states, plus the Red River Valley in Minnesota and North Dakota, comprise the major share of the U.S. fall output.

Production Areas in Canada

Production of potatoes is reported in all ten provinces of Canada (Fig. 4). The relative importance of the potato crop varies with the locality. The production of potatoes has increased since 1940. However, production from the various regions has remained more stable over the past 10 years than has been the case with U.S. production. Provinces producing more than ten percent of the total national production in 1977 were: Prince Edward Island (22%), New Brunswick (20%), Ontario (20%), Quebec (15%), and Manitoba (10%). The provinces of Alberta and British Columbia together accounted for an additional 12 percent.

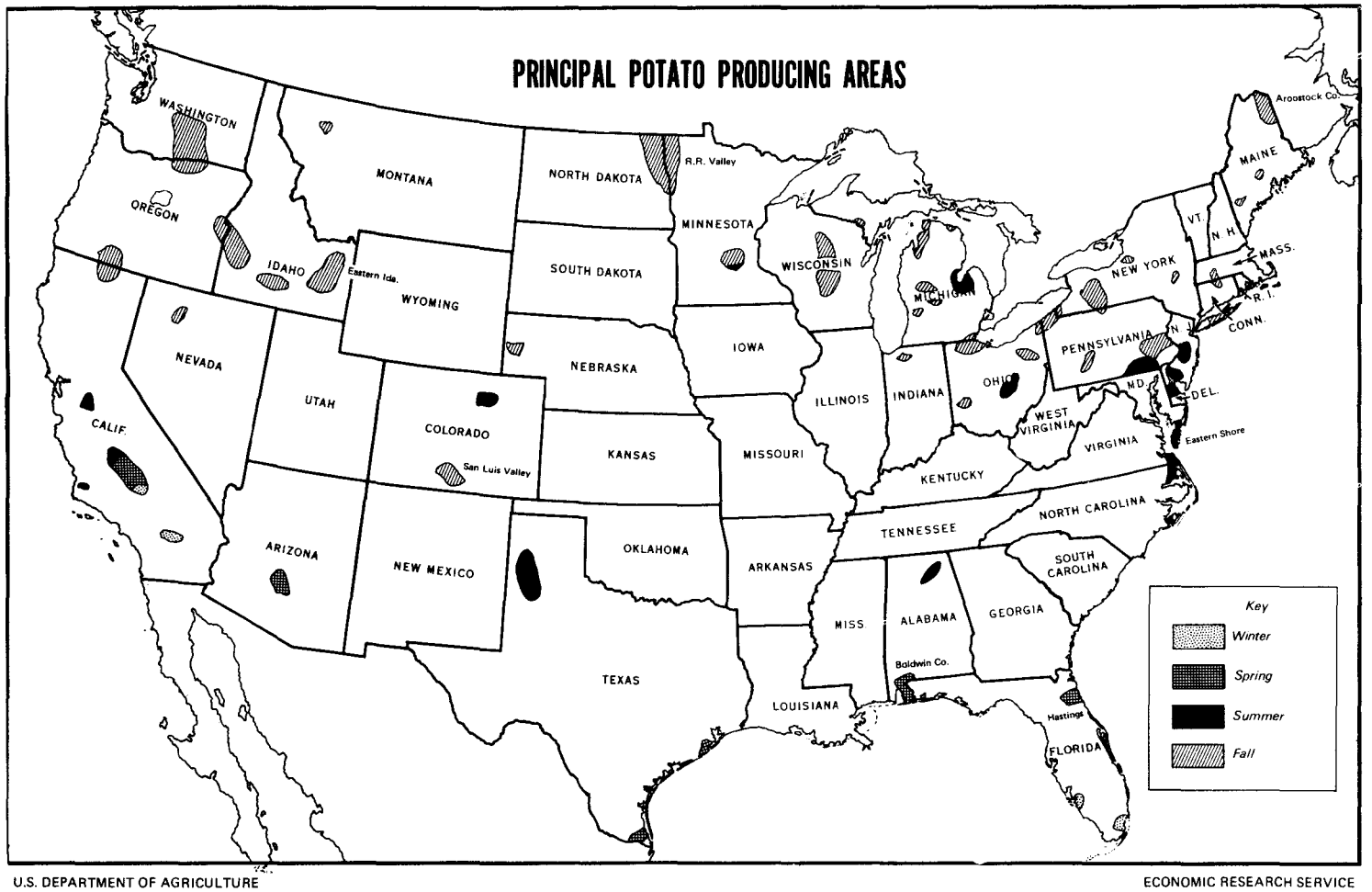

Fig. 3. Principal potato producing areas in the United States.

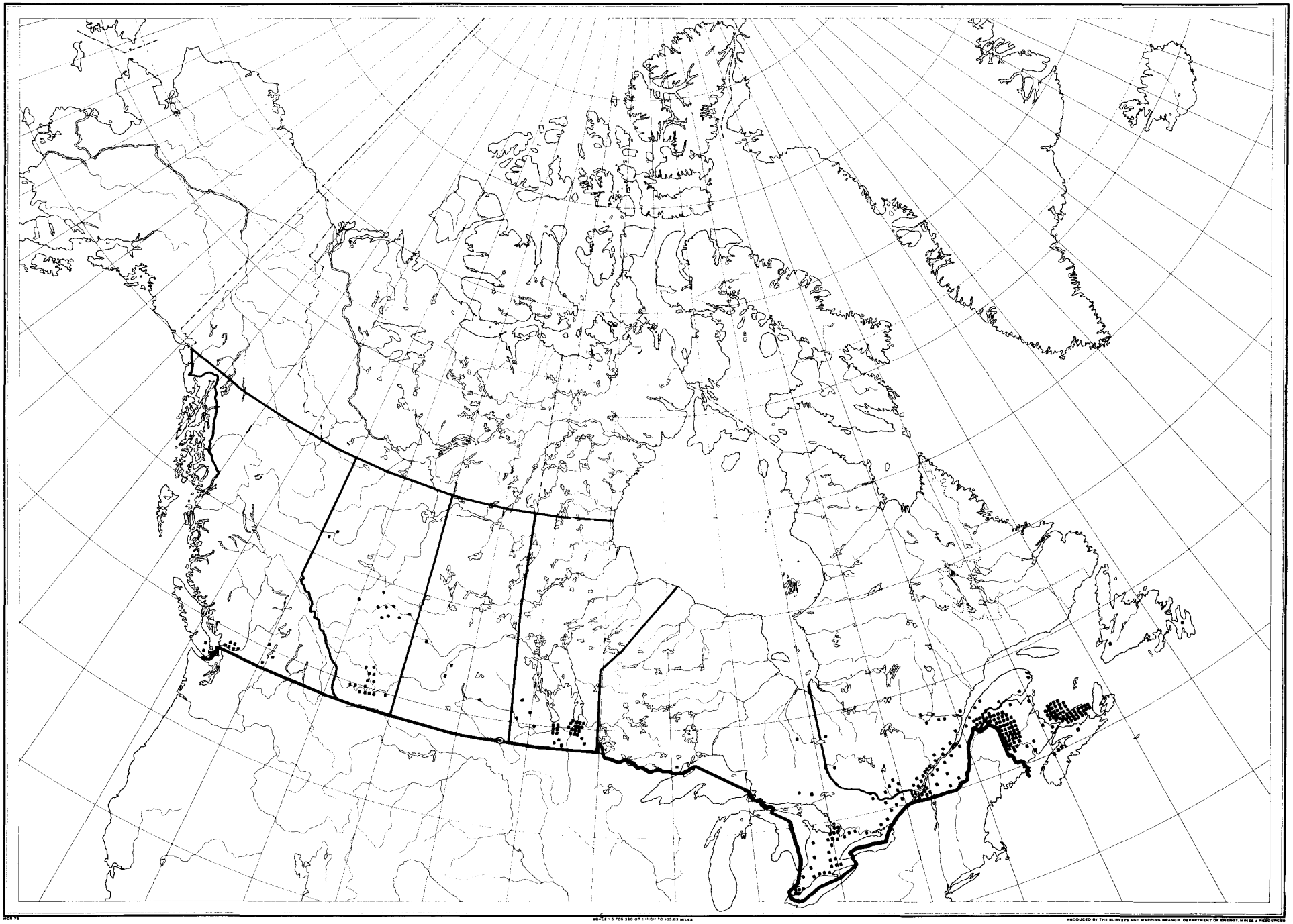

Fig. 4. Potato producing areas in Canada.

POTATO VARIETIES

Features Used to Identify Potato Varieties

The main factor other than soil fertility and good culture required for the economic production of high yields of potatoes is the use of a pure, healthy, and vigorous source of seed. Such sources can be obtained from known stocks of certified seed. Certification of seed potatoes is based upon the official inspection and approval of growing crops of potatoes by a certification agency. Certification is in large degree based upon an internationally accepted set of standards of purity as to variety and content of diseases that have an effect upon tuber quality and productivity. It is therefore necessary both for purposes of certification and preparation of the growing crop prior to the official inspection, for the grower to be able to identify the common varieties grown in his area. He should be able to recognize whether all plants in a growing crop are true to the variety named or vary because some plants are either diseased or are of another variety.

The only sure way to identify any potato variety is to be able to recognize it as such while it is a growing plant in the field. Potato varieties differ from one another in many respects and it is rare to find two that cannot be differentiated by some one characteristic whether it be vague or obvious. In general, identification of any one variety is made by knowing its basic features together with vague characteristics peculiar to each variety. The art of variety identification is not learned quickly because some of the characteristic features may be changed or modified by environment.

As with all vegetatively propagated crops, however, a potato variety is not static and slight mutations are of frequent occurrence in growing crops of all varieties. Often these mutations are usually to an inferior type of economic plant that produces either a reduced yield, a poorer tuber type, or both. It is therefore highly desirable for a seed grower not only to be able to recognize growing plants of the common varieties, but also to know the differences between desirable and undesirable types within a growing crop. Examples of the most obvious and most easily recognizable variations in any variety are the "giant hill" and the "wilding." The giant hill is taller, more vigorous, and is later maturing than normal plants. It also has smaller leaflets and more flowers. The wilding is a bushy low-growing plant with many weak stems, no flowers, few primary and secondary leaflets, large heart-shaped terminal leaflets and numerous small unmarketable tubers. Tubers from both types of these variations reproduce similar plants.

Variety Identification

Characteristics used to identify individual varieties can, to varying degrees, be modified by environment. Even so, observations of foliage, flowers, tubers, and sprouts are helpful in proper identification. Known disease reaction characteristics can also help identify some varieties. Detailed characteristics are generally published in the American Potato Journal when a new variety is released.

Foliage

Foliage characteristics which assist in variety identification are growth habit, leaves, and stems.

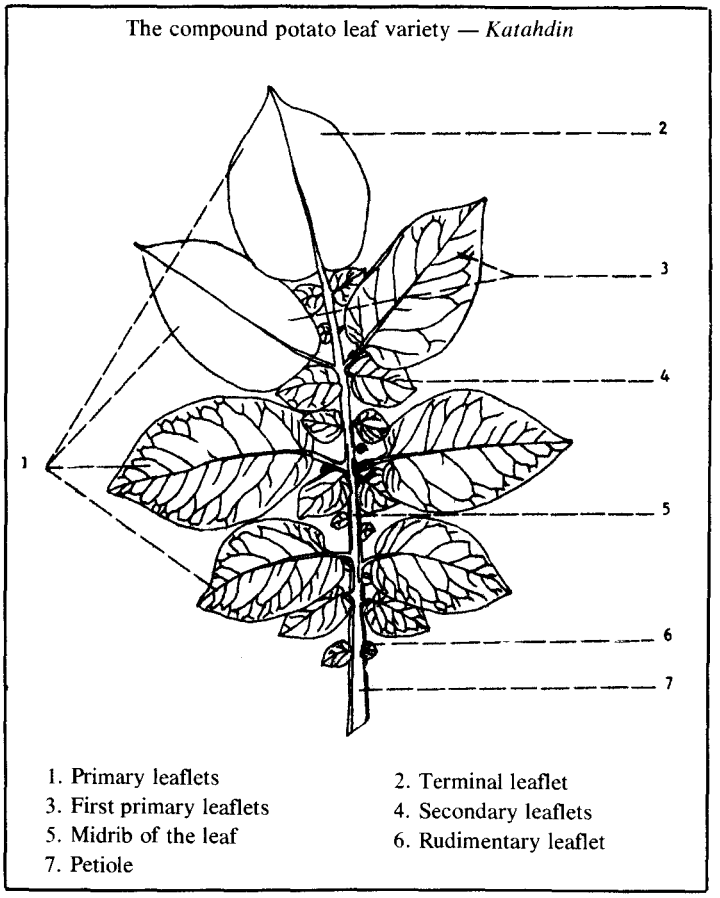

Fig. 5. Parts of a compound potato leaf (variety Katahdin).

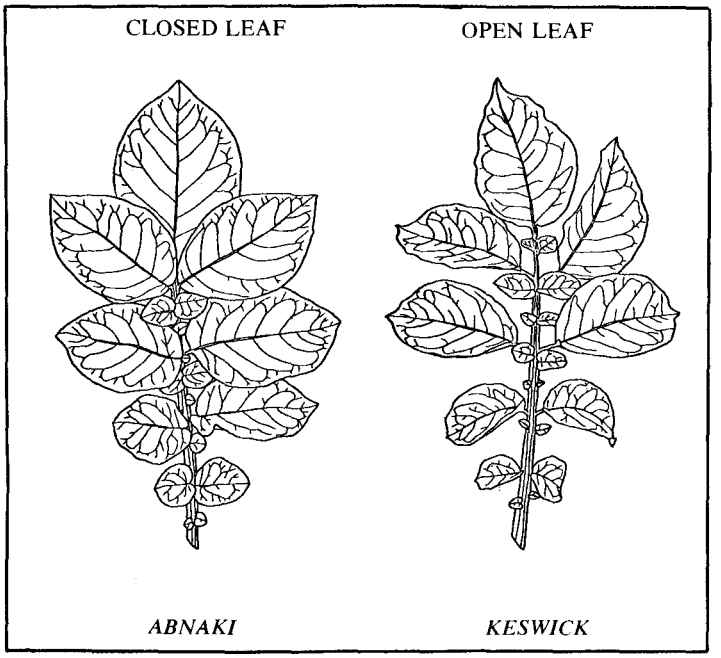

Fig. 6. An illustration of closed and open potato leaves.

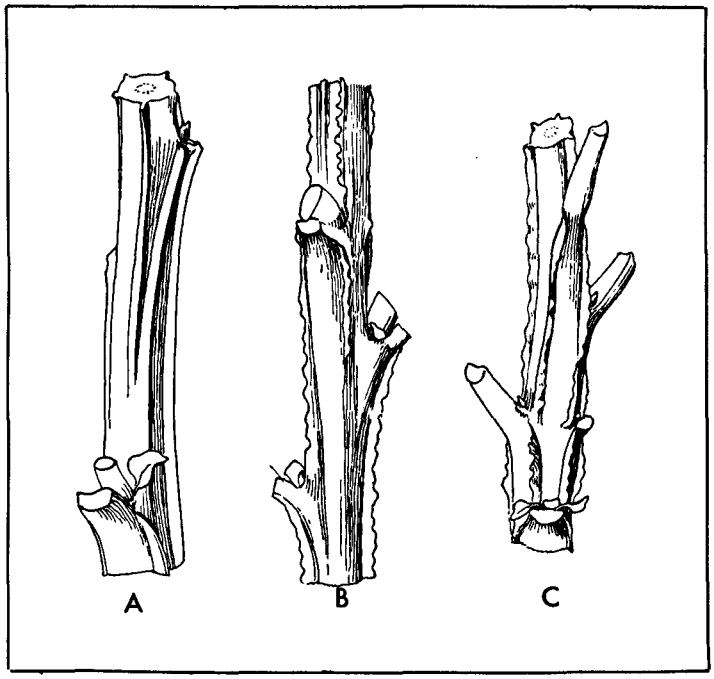

Fig. 7. Potato stems showing types of wings: A, straight, double; B, waved, double; C, slightly waved, double. Wing characters are not greatly changed by differences in environment.

GROWTH HABIT—The general appearance and vigor of the plants can be of great value in varietal identification. Unfortunately, these characteristics are the ones most affected by cultural practices and environmental conditions. However, varietal tendencies for plant height, shape, and vigor can be used in combination with specific information on foliage and flowers to help confirm identification.

LEAVES—A potato leaf is compound and made up of a petiole, a terminal leaflet, and two to four pairs of primary leaflets interspersed with secondary leaflets and occasionally tertiary or rudimentary leaflets along the midrib (Fig. 5). When pairs of primary leaflets are widely separated and there are a few secondary leaflets the leaf is described as open (Fig. 6). When primary leaflets are close together and the secondary ones are numerous the leaf is described as closed. The relative denseness (open or close) of potato leaves is a valuable feature in varietal identification. The length of the leaf, the angle between the leaf and stem, and the leaf rigidity are other leaf features used in identification.

Number of primary and secondary leaflets and leaflet characteristics vary by variety. Leaflet size, shape, color, hairiness, smoothness, glossiness, flatness, and rigidity are identifying traits, as is leaflet stalk length.

STEMS—The angles of the potato stem are extended to form structures called wings. The wings may be prominent or inconspicuous, straight or wavy, and may be so close together they appear as double wings (Fig. 7).

Stems may be uniformly green, reddish, or purple in color or may have varying degrees of mottling. Pigment may be localized at nodes or at certain internodes. Other distinguishing points are thickness, hardness, branching habit, internode length, and node size.

Flowers

Flowers and flower color are distinctive features of varieties but by themselves cannot be used to identify varieties. Colors range from white to purple and may be solid or a combination of colors. Anthers are prominent and vary in color. They may be orange, lemon yellow, or greenish yellow.

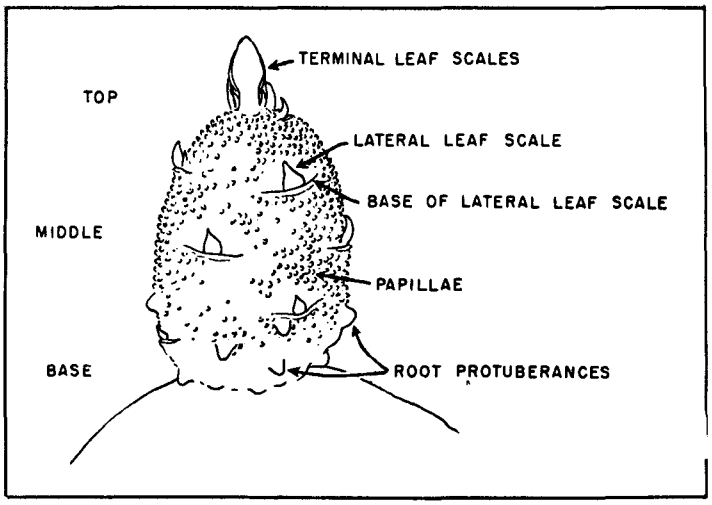

Fig. 8. Distinguishing characteristics of a sprout developed in the dark.

Other floral characters that may help confirm varietal identity are size of flower, profusion of blooms, hairiness and color of buds, and the size, frequency, and persistence of buds. Flower stalks range in color from green to various shades of purple and may be mottled. Leaf-like appendages, called stipules, at the base of the peduncles of the lowest inflorescence vary in size and may be spreading or may entirely clasp the peduncles or petioles.

Tubers

Characteristics of potato tubers that can be used to confirm identification are skin color, skin texture, shape, eye distribution, and eye depth. With the exception of skin color, these characteristics can be modified by environment and therefore cannot be used alone to identify varieties. Most varieties can be classified as whites, reds, or russets. Less common skin colors include pink, purple, and combinations of white and red or pink.

Sprouts

When tubers are exposed to diffuse light and warm temperatures for two to three weeks before planting, sprouts with color and shape characteristic of the variety are produced.

SHAPE—There are three distinct parts of a well-developed sprout: the base, the middle, and the tip (Fig. 8). Each part may vary in size and shape according to variety. The tip may be long or short and may tend to unfold its leaflets at an early or late stage. Typical shapes are ovoid, globose, or cylindrical.

COLOR—Sprout color may be uniform green or green with red or purple pigmentation. Color development can be localized to certain portions of the sprout. In some varieties color is not present in the base of the sprouts until after it is well defined in other parts of the sprout.

HAIRS—The amount and distribution of hairs on the sprouts help to further identify the sprout of a specific variety. Some are markedly hairy and others are essentially without hairs. The hairs may not be distributed over the whole sprout but according to variety may be concentrated on the tip, or the base, or the center (Fig. 9).

Disease Resistance

Specific reactions to certain plant pathogens are the basis for another method of varietal confirmation. Tests for what is termed a "hypersensitive reaction" to races of the late blight organism and viruses X, A, and Y (strain C) and perhaps an immune reaction to virus X, can be confirmatory features for some varieties.

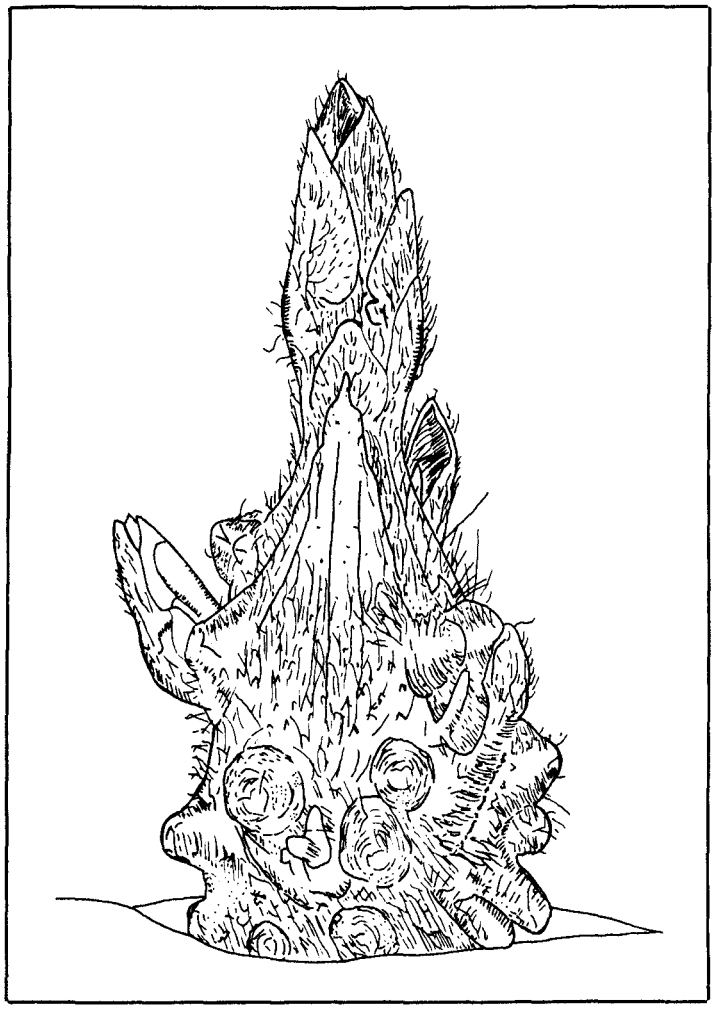

Fig. 9. An illustration of a sprout with a relatively uniform distribution of hairs.

North American Varieties From Which to Choose

A relatively large number of varieties of potatoes is grown in the early-, intermediate-, and late-crop sections of the United States and the various provinces of Canada. They differ in time of maturity, yield, appearance, cooking and marketing qualities, and resistance to various diseases and insects. All other characteristics being equal, a variety resistant to even one disease or insect is better for planting than a susceptible one.

A variety that is good in one geographical area, however, may be of little value in another. The grower is warned, therefore, against buying large quantities of high-priced seed stock of a recently introduced variety, or one reported superior in other localities, until he learns whether it is adapted to his particular environmental conditions. He had best obtain the needed varietal information from his agricultural advisor or test the variety himself on a limited scale.

A current potato variety inventory is given in Table 7. The acreage of seed certified for the 25 most popular varieties of North America is listed in Table 6. Descriptions of the leading 10 varieties grown in North America follow:

TABLE 6.—*Twenty-five major potato varieties which passed certification in the United States and Canada in 1977.*

Variety	Year Released	% of Seed Acreage	1977 Acres*
Russet Burbank	1876	36.5	108,989
Irish Cobbler	1876	0.8	2,405
Green Mountain	1885	0.2	544
White Rose	1893	0.5	1,469
Red McClure	1910	0.2	674
Katahdin	1932	7.0	20,870
Chippewa	1933	0.3	862
Sebago	1938	4.3	12,765
Ontario	1946	0.4	1,138
Kennebec	1948	18.0	53,846
Red Pontiac	1949	3.7	11,026
Pungo	1950	0.3	797
Red LaSoda	1953	2.1	6,361
Norland (+ Sports)	1957	2.9	8,631
Onaway	1961	0.2	608
Superior	1961	6.9	20,620
La Chipper	1962	0.3	940
La Rouge	1962	0.9	2,591
Viking	1962	0.3	831
Monona	1964	1.3	3,799
Norgold Russet (+ Sports)	1964	3.0	8,631
Chieftain	1966	0.2	544
Norchip	1968	5.3	15,843
Bison	1974	0.4	1,202
Centennial Russet	1976	1.7	4,959
Total			298,700

*Source: Orrin C. Turnquist, *American Potato Journal*, 55:274-290.

Russet Burbank

Late. Primarily grown in the Northwestern States, but production is increasing in the Midwest and Maine. Much of this increased production of Russet Burbank is due to its favorable marketing and processing qualities. Tubers large, long, cylindrical, or slightly flattened; skin russeted, heavily netted; eyes numerous and shallow; flesh white. Flowers white and few in number. Some scab resistance but susceptible to most other potato diseases, especially leaf roll, net necrosis, and verticillium wilt. Cooking and processing qualities very good; keeps well in storage.

Kennebec

Main season. Has wide adaptation. Tubers large, elliptical to oblong, medium thick; eyes shallow; skin smooth, creamy buff; flesh white. Flowers white. Resistant to mild mosaic, and net necrosis in the tubers caused by seasonal infection with the leaf roll virus. Is moderately resistant to late blight. Susceptible to verticillium wilt. Considered general-purpose potato that bakes, boils, and fries satisfactorily. Desirable for french frying or for chipping.

Katahdin

Main season. Has wide adaptation. Tubers large, elliptical to round, medium thick; skin smooth, creamy buff; eyes shallow, same color as skin; flesh white. Flowers lilac with white tips. Resistant to mild mosaic, net necrosis, and brown rot, and immune to wart; not infected with leaf roll as readily as most other varieties. Cooking quality medium to good.

Norchip

Medium early. Tubers medium, mostly round, medium thick; skin smooth, white; lateral eyes shallow, apical eyes moderately deep, eyes same color as skin; flesh white. Flowers white. Possesses some resistance to common scab. Generally produces light-colored chips. Sprouts early in storage.

Superior

Early. Has wide adaptation. Tubers medium, relatively uniform in size, mostly round, slightly flattened; skin slightly checked, white; eyes moderately deep, same color as skin; flesh white. Flowers lavender. Resistant to common scab and net necrosis. Suitable for fresh market and early chip processing.

Sebago

Late. Has wide adaptation with pockets of production located in Florida and the Southern states. Tubers large, elliptical to oblong, medium thick; skin smooth, white; eyes shallow, same color as skin; flesh white. Flowers lilac with slightly lighter tips. Resistant to mild mosaic and net necrosis, and reported to have yellow dwarf resistance in New York and Wisconsin and brown rot resistance in Florida. Possesses moderate degree of field resistance to late blight and some resistance to common scab. Susceptible to blackleg and has a tendency toward enlarged lenticels. Generally used as a fresh market variety but some of the southern crop is processed into potato chips.

Red Pontiac

Late. High yielding variety of value in sections where red varieties are in demand. Similar to Pontiac except for darker red skin. Tubers large, oblong to round, blunt at ends; skin smooth or sometimes netted, uniformly red; eyes medium deep, red; flesh white. Flowers light reddish purple with white tips. Susceptible to most common potato diseases. Cooking quality good.

Norgold Russet

Early. Tubers oblong to long, attractive, medium thick; skin uniformly netted, brown in color; eyes shallow, well distributed, same color as skin at harvest but may develop pink color in storage; flesh white. Flowers pink. Resistant to common scab. Is susceptible to verticillium wilt and has some tendency for hollow heart. Sprouts early in storage. Primarily marketed fresh as an early russet.

Norland

Early. Tubers smooth, medium sized, mostly round; skin smooth, medium red in color; eyes relatively shallow and same color as skin; flesh white. Flowers purple. Resistant to common scab. Susceptible to air pollution injury. Sprouts early. Produces a high percentage of U.S. No. 1 tubers. Is used as a fresh market variety or can be processed into chips early.

Red LaSoda

Medium early. Tubers round to oblong, slightly irregular in shape, slightly flattened; skin smooth, bright red; eyes medium deep, same color as skin; flesh white. Flowers purple. Produces high yields. Has some resistance to mosaic. Grown for fresh market in southern states.

Table 7

POTATO VARIETY INVENTORY

Certification Section, PAA

Variety Name	Year Released	Agency	Published Release Data	Parentage
Abnaki	1970	USDA, NY, ME	APJ 47:229 1970	X1276-185 x B4116-2
Alamo	1967	USDA, TX	APJ 45:139-141 1968	Kennebec x Merrimack
Alaska Frostless	1967	AK, USDA	APJ 46:1-4 1969	AK 114 x 27-11
Alaska Red	1977	USDA	APJ 54:365-369 1977	Red Beauty x 11-57-1-59
Alaska Russet	1963	AK, USDA	APJ 41:137-139 1964	Columbia Russet sdlg. x MN 15-2
Alaska 114	1959	AK, USDA	APJ 37:108-110 1960	13-1 x Cobbler
Allehanna	1960	PA		
Anoka	1965	MN	U of MN, Misc. Rep. 59 1965	B402-1 x Cherokee
Antigo	1955	WI	APJ 32:407-410 1955	Menominee x 302.44-6
Arenac	1962	MI, IA, USDA	Unpublished	B595-76 x Ia 872-4
Ashworth	1946	NY		
Atlantic	1976	USDA, FL, VA, NJ, ME	APJ 55:141-146 1978	USDA B5141-6 x Wauseon
Avon	1962	N.B., Canada	APJ 39:363-367 1962	USDA X96-56 x 1464-26
Bake-King	1967	NY	APJ 44:287-291 1967	Gr. Mt. x Merrimack
Beach	1945	IA		
Beauty of Hebron	1878	Private	USDA Circ. 741 1951	Seedling of Garnet Chili
Belchip	1978	USDA, FL, NJ, ME, VA	APJ 55:537 1978	B5141-6 x Wauseon
Bellisle	1975	N.B., Canada	APJ 52:51-55 1975	834C (29) x F4724
BelRus	1978	USDA, FL, ME	APJ 55:538 1978	Penobscot x W39-1
Bison	1974	ND	APJ 54:189-194 1977	ND 4652-2R x ND 5124-1R
Blanca	1959	USDA, CO	APJ 38:236-239 1961	USDA B 929-32 x USDA X627-164
Blue Christy	1885	Unknown	USDA Circ. 741 1951	Not known
Blue Victor (Sport)		Unknown	USDA Circ. 741 1951	Sport of Peerless
Boone	1955	USDA, NC	APJ 33:315-318 1956	B231-3 x T1-5
Bounty	1959	NB	NB Exp. Sta. quart. Spring 1960	NB 217.4[illegible]-1 x S.N.D.-136
Brown Beauty	1861	VT	USDA Circ. 741 1951	Seedling of Garnet Chili
Burbank	1876	Private	USDA Circ. 741 1951	Early Rose sdlg.
Butte	1978	USDA, ID, WA, OR	APJ 55:685-690 1978	A492-2 x Norgold Russet
Calrose	1946	USDA	APJ 23:343-347 1946	Ackersegen x Katahdin
Canoga	1951	NY	APJ 28:672-674 1951	1938 Sdlg. x Katahdin
Canso	1951	Canada	APJ 28:697-698 1951	S. demissium x Earlaine x Kat. x Kat. x Kat. x Kat. x Kat.
Canus	1949	USDA, Canada	APJ 26:326-330 1949	X9-11 x USDA 24642
Cariboo	1967	Canada	APJ 45:247-249 1968	K113-1 x 1256(A)23
Cascade	1969	USDA, WA	APJ 47:261-263 1970	P1214372 x USDA B3820-14

POTATO VARIETY INVENTORY (Cont.)

Certification Section, PAA

Variety Name	Year Released	Agency	Published Release Data	Parentage
Catoosa	1959	USDA, TN, LA	APJ 38:300-303 1961	Pontiac x (X96-56)
Cayuga	1946	USDA, NY	APJ 23:315-329 1946	Hindenburg x Katahdin
Centennial Russet	1976	CO, USDA	APJ 54:603-605 1977	Nooksack x W12-3
Charles Downing	1887	Private	Potato Handbk. p. 23 1959	Not known
Chenango	1946	NY	APJ 24:331-335 1947	1097 USDA 46110 x NY BXS/1
Cherokee	1951	USDA, IA, IN	APJ 31:53-58 1954	USDA X528-170 x (USDA X96-56)
Chieftain	1966	IA, USDA	APJ 45:293-296 1968	IA 1027-18 x LA 1354
Chinook	1965	N.B., Canada	APJ 43:1-5 1966	Menominee x USDA 96-56
Chippewa	1933	USDA	USDA Circ. 741 1951	USDA Sdlg. 40568 x USDA Sdlg. 24642
Chisago	1949	USDA, MN	APJ 26:264-269 1949	I Cobbler x 13-1
Cortland	1947	NY	APJ 27:1-10 1950	Russet Rural x Katahdin x Menominee
Dakota Red (Jersey Red Skin)	1883	Private	USDA Circ. 741 1951	Not known
Dazoc	1953	NB	Nat. Pot. Breeding 23rd An. Report p. 161	Triumph x Neb. 49.40-3
Delus	1954	USDA, DE	APJ 31:410-413 1954	Mohawk x USDA 96-56
DeSota	1948	LA	APJ 25:89-91 1948	Triumph x Katahdin
Earlaine	1937	USDA	USDA Circ. 493 1938	I Cobbler x 43055
Earlaine No. 2	1938	USDA	USDA Circ. 741 1951	Not known
Early Gem	1953	USDA, ID, ND	APJ 32:79-85 1955	R. Burbank x X96-56
Early Ohio	1871	Private	USDA Circ. 741 1951	Seedling of Early Rose
Early Rose	1861	Private	USDA Circ. 741 1951	Seedling of Garnet Chili
Emmet	1962	MI, IA, USDA	Unpublished	B595-76 x Ia 872-4
Empire	1945	NY	APJ 22:357-362 1945	AZK-3 x No. 9
Erie	1936	OH, USDA	APJ 22:29-32 1945	45146 x Earlaine
Earli-Red	1960	Grower-Breeder ND	APJ 38:78-80 1961	43.17-16 x 43.23-6
Essex	1947	NY	APJ 27:1-10 1950	NY ABX/6 x 1152
Excel	1957	NB	NB Exp. Sta. Quart. Spring 1960	NB 143.47-16 x NB 59.41-PL
Fillmore	1947	NY	APJ 27:1-10 1950	NY AZK-3 x No 9
Fundy	1960	Canada	APJ 37:274-277 1960	USDA 96-56 x Keswick
Garnet Chili	1853	NY	USDA Circ. 741 1951	Seedling of Rough Purple Chili
Glenmer	1946	NY	APJ 27:1-10 1950	NY ABX/6 x 1152
Golden	1935	USDA	USDA Circ. 741 1951	43106 x 43543
Grand Falls	1966	N.B., Canada	APJ 43:323-327 1966	F 4834 x 1682 c(1)
Green Mountain	1885	VT	USDA Circ. 741 1951	Excelsior x Dunmore
Haig	1957	NB	NB Exp. Sta. Quart. Spring 1960	Cayuga x MN 43
Harford	1947	NY	APJ 27:1-10 1950	Russet Rural x NY AFY/15
Harmony Beauty	1880	ME	USDA Circ. 741 1951	Not known
Hi Plains	1965	NB	APJ 42:361-365 1965	USDA 528-170 x Kasota
Houma	1936	USDA, LA	USDA Circ. 420 1936	Chas. Downing x Katahdin
Hudson	1972	NY	APJ 50:212-215 1973	Kennebec x X96-56
Hunter	1963	N.B., Canada	APJ 40:275-278 1963	F 4823 x 834 (C)
Huron	1958	N.B., Canada	APJ 40:715-720 1963	Hindenburg x Sebago
Irish Cobbler	1876	MA	USDA Circ. 741 1951	Sport of Early Rose
Jewel	1968	NY - private	APJ 46:83-87 1969	Sebago x Stately
Katahdin	1932	USDA	APJ 8:121-125 1931	USDA 40568 x USDA 24642
Kasota	1943	MN, NB	APJ 20:25-27 1943	Triumph x 29-13
Kennebec	1948	USDA, ME	APJ 25:351-361 1948	B127 x 96-56
Keswick	1951	Canada	APJ 28:698-699 1951	S demissum x Earlaine x Earlaine x Earlaine x Gr. Mountain
Knik	1953	AK, USDA	APJ 30:148-149 1953	Arctic Sdlg. x 56-1
Lake	1945	USDA		Richter's Jubel×USDA 44537
La Chipper	1962	LA	APJ 40:130-132 1963	Cayuga x Gr. Mountain
La Rouge	1962	LA	APJ 40:130-132 1963	LO 2-5 x LO 2-5
La Salle	1948	LA	APJ 25:89-91 1948	Chippewa x Triumph inbred
La Soda	1948	LA	APJ 25:89-91 1948	Triumph x Katahdin
Lenape (withdrawn)	1967	USDA, PA	APJ 45:142-145 1968	USDA 47156 x USDA B3672-3
Madison	1947	NY	APJ 27:1-10 1950	Earlaine x NY AMY-4
Manota	1952	Canada	APJ 30:50-52 1953	MN 11-1-2-1 x MN 9-4
Marygold	1949	USDA, MD	APJ 26:25-32 1949	Earlaine x USDA 45208
McCormick	1882	IN	USDA Circ. 741 1951	Not known
Menominee	1940	USDA	APJ 21:305-311 1944	Richter's Jubel x USDA Sdlg. 44537
Merrimack	1954	USDA, NH	APJ 32:93-99 1955	X96-56 x Saranac
Mesaba	1938	MN	APJ 15:89-91 1938	Russet Rural x MN 41-1
Mohawk	1935	USDA	APJ 20:79-86 1943	Katahdin x Gr. Mountain
Monona	1964	Frito-Lay	APJ 42:253-255 1965	USDA B1299-15 x USDA B1268-46
Nampa	1973	ID	APJ 50:296-299 1973	Norgold Russet x A589-65

POTATO VARIETY INVENTORY (Cont.)

Certification Section, PAA

Variety Name	Year Released	Agency	Published Release Data	Parentage
Navajo	1958	USDA, CO	APJ 38:236-239 1961	USDA B929-32 x USDA X627-164
Nipigon	1978	Canada	APJ 55:107-110 1978	F53026 x F51043
Nooksack	1973	WA	APJ 51:99-103 1974	Kennebec x A501-13
Norchief	1968	ND	APJ 46:298-301 1969	ND 4468-1R X Redkote
Norchip	1968	ND	APJ 46:254-258 1969	ND 4731-1 x M 5009-2
Nordak	1957	ND	APJ 35:774-777 1958	(ND 457-1) selfed
Norgleam	1957	ND	APJ 35:774-777 1958	(ND 457-1) selfed
Norgold Russet	1964	ND	APJ 42:201-204 1965	A 119-1 x ND 2475-8
Norkota	1931	USDA	USDA Circ. 665 p. 6 1943	Rural New Yorker x Katahdin
Norland	1957	ND	APJ 36:12-15 1959	Redkote x ND 626
Ona	1961	USDA	APJ 39:464-467 1962	USDA B2968-31 x USDA B3021-3
Onaway	1961	MI, USDA	APJ 38:353-355 1961	USDA X96-56 x Katahdin
Oromonte	1967	USDA, CO	APJ 45:297-299 1968	Katahdin x USDA 43106
Ontario	1946	USDA, NY	APJ 23:315-329 1946	Richter's Jubel × USDA 44537
Osage	1953	USDA, IA	APJ 31:299-304 1954	USDA X245-186 x Katahdin
Osseo	1954	MN	APJ 31:273-277 1954	I. Cobbler x 56-1
Pawnee	1942	CO, USDA	USDA Circ. 665 1943	Rural NY No. 2 x Katahdin
Peconic	1966	NY	APJ 43:450-452 1966	LNA-106 x Katahdin
Pele	1978	HI	APJ 55:573-576 1978	57-AH-9 x Anita
Penobscot	1963	ME, USDA	APJ 41:140-144 1964	X927-3 x Katahdin
Peerless	1862	VT		Seedling of Garnet Chili
Pennchip	1963	PA	APJ 41:54-58 1964	Russet Rural x Earlaine
Pioneer	1963	NB	APJ 40:81-87 1963	NB 225.43-1 x MN 113-1-45
Placid	1946	NY	APJ 24:321-325 1947	ABX/6 x AFY/5
Platte	1965	NB	APJ 42:361-365 1965	Redbake x NB 29.47-2
Plymouth	1955	USDA, NC	APJ 33:296-299 1956	Mohawk x USDA 96-56
Pontiac	1938	USDA, MI	MI. Quart. Bul. 21:174-175 1939	Triumph x Katahdin
Potomac	1945	MD, USDA	APJ 22:262-266 1945	Rural NY x Katahdin
Pride	1968	NY - private	APJ 46:88-90 1969	Sebago x AG56
Progress	1950	NB	Nat. Pot. breeding 23 An. Report p. 172	USDA 0183 x MN 5-10-3-8
Pungo	1950	USDA, VA	APJ 31:322-326 1954	X96-44 x X528-170
Raritan	1970	NJ	APJ 47:264-267 1970	834(29) x F4519
Redbake	1956	NB		MN 41-2-01 x CO 3719
Red Beauty	1955	WI, ND	APJ 32:346-349 1955	MD1 x Cayuga
Redburt	1953	MN	APJ 30:186 1953	Selection from Satapa
Redglo	1954	NB		MN 29-32-1-34 x Pontiac
Redkote	1953	Private		USDA 116-10X x Pontiac
Red La Soda	1953	USDA, LA	APJ 31:40-43 1954	A mutation of La Soda
Red McClure	1910	CO	USDA Circ. 741 1951	Sport of Improved Peachblow
Red Pontiac	1949		Pot. Hdbk. 1959:34-35	Clonal mutation from Pontiac
Redskin	1960	USDA, TX	APJ 38:81-84 1961	Pontiac x USDA B400-1
Red Warba	1933	MN	APJ 16:185-190 1939	Mutant chimera Warba
Reliance	1963	USDA, MN, ND	APJ 40:406-410 1963	Tawa x Early Gem
Rural New Yorker #2	1888	NY	USDA Cir. 741 Apr. 1946	Not known
Rushmore	1956	LA	APJ 34:68-69 1957	Gr. Mountain x Katahdin
Russet Arenac	1965	MI	Unpublished	Sport of Arenac
Russet Burbank	1876	Private	USDA Cir. 741 1951	Sport of Burbank
Russet Rural	1903	MI	USDA Cir. 741 Apr. 1946	Sport of Rural New Yorker #2
Russet Sebago	1947	WI		Sebago mutation
Sable	1965	N.B., Canada	APJ 43:154-157 1966	F5294 x F4724
Saco	1954	USDA, ME	APJ 32:41-48 1955	USDA 41956 x USDA (X96-56)
Satapa	1949	USDA, MN	APJ 26:264-269 1949	Cobbler x 13-1
Sebago	1938	USDA	USDA Cir. 503 1938	Chippewa x Katahdin
Seminole	1969	Private	APJ 47:35-8 1970	USDA B3672-3 x USDA B4715-6
Seneca	1946	USDA, NY	APJ 23:315-329 1946	Hindenburg x Katahdin
Sequoia	1931	NC, USDA	APJ 22:97-103 1945	Katahdin x Gr. Mountain
Sheridan	1953	NB	Nat. Pot. breeding 23 An. Rep. p. 161	Triumph x NB 49.30-3
Shoshoni	1963	ID, USDA	APJ 41:95-99 1964	B2913-24 x Early Gem
Sioux	1969	NB	APJ 47:163-168 1970	NB 240.54-1 x NB 226.49-1X
Snowchip	1973	AK, USDA	APJ 52:47-50 1975	Ontario x Stately
Snowdrift	1947	NY	Pot. Hdbk. 1959 p. 37	Earlaine x *S. demissum* sdlg.
Snowflake	1961	ND	APJ 40:271-274 1963	ND 457-1 x Kennebec
Stately	1961	USDA, AK	APJ 38:244-248 1961	X-792-94 x AK 114
Superior	1961	WI	APJ 39:19-28 1962	M59.44 x X96-56
Shurchip	1969	NB	APJ 47:124-129 1970	NB 25.47-7X x NB 226.49-1X
Targhee	1973	ID	APJ 50:293-296 1973	Norgold Russet x A463-4

POTATO VARIETY INVENTORY (Cont.)

Certification Section, PAA

Variety Name	Year Released	Agency	Published Release Data	Parentage
Tawa	1956	USDA, IA, MI	APJ 36:267-274 1959	USDA B595-76 x USDA B76-23
Teton	1946	USDA, WY, ME	APJ 23:379-389 1946	USDA 45146 x Earlaine
Tobique	1977	N.B., Canada	APJ 54:419-424 1976	Cariboo x F45019
Triumph	1878	Private	USDA Circ. 471 1951	Peerless x Early Rose (Bliss, Red)
Viking	1962	ND	APJ 41:253-255 1964	Redskin x Nordak
Warba	1933	MN	MN Hort 61:137 1933	Triumph x 4-16
Waseca	1949	USDA, MN	APJ 26:264-269 1949	Triumph x 15-2-10
Wauseon	1967	USDA, NY	APJ 45:146-149 1968	USDA B5149-8 x Katahdin
White Rose	1893	Private	USDA Cir. 741 1951	
Wischip	1973	WI		55-232-58 x W231
Wyred	1967	WY	APJ 45:33-35 1968	NB 127-47-5 x Katahdin
Yampa	1949	USDA, CO	APJ 26:335-342 1949	USDA x 245-186 x Katahdin
York	1969	Canada	APJ 47:201-204 1970	F5569 x F5348

GROWTH REQUIREMENTS OF THE POTATO

Potential potato yield in any area is determined by the amount of radiant energy available, number of frost-free days, and the amount and uniformity of the water supply. All other known needs can be added. The many important factors that determine production can be divided into those over which a grower has some degree of control and those over which he has little or no control. The maximum potential production is limited by the uncontrollable factors. The ability of each grower to manage the controllable factors and the degree to which they are optimized, determine the actual level of production.

1. Nongrower controlled factors include: frost-free period, air temperature, soil temperature, light intensity, day length, humidity, and soil type.

2. Grower controlled factors are: soil moisture, crop pests, days grown, fertility, seed quality, seed piece size, plants per acre, timely operation, and soil condition.

Soil Requirements

Potatoes grow well on a wide variety of soils. In some areas where potatoes are commercially grown, the soils are acid, whereas, in others they are alkaline. Ideal soil for potato growing is deep, well-drained, and friable. The soil is a water and nutrient reservoir through which air exchange between the soil and atmosphere must readily occur. Without oxygen the roots do not efficiently absorb either water or nutrients. In areas where potatoes receive moisture entirely from rainfall the most desirable soils have a high water-holding capacity without a tendency to become puddled when wet or cloddy when dry. In the irrigated areas, especially where sprinkler irrigation is used, soil type is less critical because water can be applied as needed in quantities sufficient to meet the needs of the plants without undue runoff, leaching of nutrients, or puddling.

Soils high in clay content require special treatment such as proper crop rotations, cover crops, and timely tillage operations to keep them productive over long periods of time. Sandy soils which contain little clay, or little organic matter and have almost no soil structure, when properly irrigated and fertilized will produce high yields of tubers with excellent culinary and processing quality. Wind erosion can be a problem on sandy soils; however, cultural practices where cover crop residues are left on or near the surface provide good control of wind blown soil.

All soils can become infested with disease causing organisms such as scab, wilts, and nematodes, also soil-borne insects, such as grubs and wireworms. In such cases, disease-resistant varieties, soil fumigation, and application of insecticides to the soil can provide economical control if high yields can be obtained.

The cultural practices desirable in any production operation must be adapted to the soil in which potatoes are being grown. The potato plant requires an adequate supply of moisture, nutrients, and air throughout the growing period. The amount of moisture and nutrient which must be provided is determined by the fertility status of the soil and the rooting depth of the plants. Any interruptions in growth, regardless of the cause, can result in poor quality tubers. It appears to be especially easy to cause malformation of tubers during the early stages of growth.

In recent years the production of potatoes has tended to be located in areas where the required cultural practices can be accomplished mechanically with a minimum of delay due to untimely changes in the weather and where the requirements for optimum plant growth can be provided as needed.

Temperature and Moisture

All processes of living plants are governed by enzymes and all enzymes function faster at high temperatures, until eventually at some maximum temperature the enzymes are inactivated. The potato has long been classified as a short day, cool season crop, but does very well at high temperatures when uniform supplies of water in quantities sufficient to meet evapotranspiration demands are supplied. The highest yields are currently being produced in areas where the daytime temperature is often over 100°F (38°C) during the hottest part of the growing season, such as in Washington's Columbia Basin, eastern Oregon, California, and Nevada. The Russet Burbank, the predominant variety in these areas, is not unique in its adaptation to these environmental conditions, as evidenced by the fact that new cultivars as well as many older varieties produce their top yields in these areas. The critical factor is a supply of water at soil moisture tensions low enough to keep the stomata open during the heat of the day.

Yield potential or photosynthate produced is a result of rate/hour, times number of hours per day, times number of days, times the number of functioning plants per production unit. Yield is the difference between the photosynthate produced as expressed in the formula above minus the amount used up by the living plant (respiration). Cool night temperatures are an asset because they reduce respiration. The vine temperatures change more rapidly and to a greater degree than tuber temperatures because of the latent heat capacity of the soil.

Contrary to expectations in a hot environment, high specific gravity tubers and high yields can be produced at the same time. As a result the tubers from high yielding plants are excellent for most forms of processing.

Specific gravity of the tubers can be influenced by the relative rates of four physiological processes, i.e., respiration, transpiration, photosynthesis, and water absorption. Respiration pertains to the "rate of living" — the higher the temperature, the faster the utilization of carbohydrates produced by photosynthesis. The amount of carbohydrates produced depends upon the rate of photosynthesis and the length of time that it continues. Consequently, there is a direct relationship between length of the growing season and production of high yields of high dry matter content (high specific gravity) potatoes. There is also a direct relationship between the high yields and amounts of nutrients since the amount of nutrients in a crop is directly related to the size of the crop of potatoes. Fertilization may have little direct effect but a large indirect effect on the specific gravity because of the effect of size of the plant on the relative rates of water lost by transpiration and water absorption by the roots.

The specific gravity of potatoes attached to living plants in the field can change rapidly because of water movement into and out of the tubers. When transpiration (water loss through the leaves) ex-

ceeds the rate of water absorption by the roots, the vines draw water from the tuber, causing the tuber to decrease in weight, shrink in size, and at that point in time have an increased specific gravity. This process will continue until the leaf cells lose their turgor pressure, the leaves wilt, the stomata close, and photosynthesis ceases.

If the rate of water absorption by the roots exceeds water loss by transpiration, the excess water is pumped into the tubers and they expand, increase in weight, become more brittle, and the specific gravity decreases. The increase in weight of potatoes and decrease in specific gravity, because of absorbed water, are at times sizeable.

Rotations

Potatoes should be grown in a crop rotation that will enhance the soil fertility, maintain a loose friable soil condition, reduce weeds, increase organic matter level, conserve soil moisture, and reduce crop loss from insect damage and plant diseases. No specific crop rotation can be given, as combinations vary from place to place. Potato growers must develop the rotation best suited to local environmental conditions, crop alternatives, and market prospects.

In general, long rotations (potato crops planted three or more years apart on the same land) are particularly good for reducing potato losses caused by soil-borne organisms causing such diseases as scab, verticillium wilt, and fusarium wilt. Wheat wireworms (*Agriotes mancus*) increase in abundance in fields planted for several years to hay and grass crops and may be a serious threat to a potato crop immediately following the plowing under of a heavy sod, alfalfa, or clover. On the other hand, the Pacific Coast wireworm (*Limonius canus*) increases in fields under intense cultivation, but the population decreases when fields are planted to hay crops.

Soil Preparation and Improvement

A well prepared seedbed is desirable, but over preparation wastes energy and destroys soil structure.

Plowing the soil has been a conventional practice in preparing the land for potato planting. Depending on soil type, amount of precipitation, and other factors, fields should be plowed just prior to planting or in some areas fall plowed. Fall plowing aids decay of the plant debris and leaves the soil exposed to the natural weathering processes during the winter months. How deep to plow depends largely on the depth of the surface soil and the character of the subsoil. Deep and fertile surface soil should be plowed to a depth of 8 to 12 inches (20.3 to 30.5 cm), but shallow soil should be plowed no deeper than an inch below the plow sole. A 14-inch (35.5 cm) wide or larger plow is required to do a good job of plowing for potatoes. If much trash is to be turned under, plows with 16- and 18-inch (40.6 to 45.7 cm) bottoms and with large clearance are needed (Fig. 10). It is

Fig. 10. Plowing with roll-over moldboard plows is a popular practice which eliminates back-furrows and dead-furrows. Often a clod buster, spring tooth harrow or other smoothing implement is attached to the plows to prepare the soil for planting.

Photo: Washington State University

preferable to plow sloping lands in very late fall or in the spring and leave them rough to help prevent erosion. Strip and/or contour plowing of sloping lands will also help control erosion.

Fall-plowed land should be worked the following spring as soon as the land is dry enough to work. Implement traffic over the field should be limited to a minimum to help prevent soil compaction but adequate for weed control and obtaining a loose friable seedbed. On some fields it may be necessary to final till the land with the spiked-tooth harrow to break clods and level the ground. The spiked-tooth harrow is also effective in eradicating small weeds.

In general, heavy soil benefits most from fall plowing because the action of frost, snow, and winter rain on exposed soil makes it more mellow. Fields from which soil is likely to be washed away by winter rains and rapidly melting snow, however, should be plowed in the spring.

Prevention of soil erosion, either by wind or water, cannot be over-emphasized. Any waste of topsoil ultimately means a serious loss of capital to the potato grower.

In some parts of the West, alfalfa is turned under just before potato-planting time, and neither the cutoff crowns nor the surviving alfalfa plants give trouble. Thorough plowing of alfalfa soil is essential. The plow should be equipped with alfalfa shares, so that no plants will be left uncut.

Many growers find it beneficial to loosen heavy soil to a depth of 16 to 20 inches (40.6 to 50.8 cm) with a land chisel. Precision tillage, shanking 16 to 24 inches (40.6 to 60.9 cm) directly below where the seedpieces are to be planted has resulted in an increase in soil aeration and improved drainage of some soils.

Soil should not be plowed when too wet. If plowed when too wet, the land is likely to remain in poor physical condition throughout the growing season, with slow water infiltration, poor soil aeration, poor drainage, and clods at harvest time. Where heavy rainfall may occur, potato land can be ridged to facilitate better runoff of excess water and to provide better drainage.

Basin listing is sometimes a good way to prepare an area for dryland potato growing. The basin lister makes a furrow with small earthen dams at regular intervals. The dams keep rainwater from running off the surface and thus increase the quantity of moisture that penetrates the soil. The same method has been adapted to uneven sprinkler-irrigated land in the West. In some cases, use of damming or pitting has been helpful on soils with low surface infiltration rates. If fields are to be furrow irrigated, proper leveling of the land is essential before final preparation of the seedbed.

Building Up Soil Organic Matter Content

One soil problem in practically all potato regions, except those with muck and peat, is that of supplying and maintaining a desirable level of organic matter in the soil. In warm regions with long growing seasons, the decomposition of organic matter in the soil is rapid and almost continuous. In colder regions, decomposition is less rapid in summer and does not occur appreciably during the winter. The advantages of organic matter in the soil are many. An ample supply of decaying organic matter helps to keep the soil loose and mellow and thus reduces soil compaction. Potato tubers develop and maintain normal shape better in loose, well-aerated soils. Organic matter facilitates plowing and cultivating; it enables roots of potato plants to penetrate the soil more readily, and it improves water retention; it provides food energy for the growth of desirable soil microorganisms and supplies plant nutrients.

Potatoes, as a crop, provide little organic matter to be returned to the soil. General methods of getting organic matter into the soil include a crop rotation in which legumes or other crops are grown and plowed under as a green-manure crop. Such crops include crimson or red clover, vetch or a combination of peas and vetch, soybeans, cowpeas, rye, oats, barley, wheat, millet, Sudan grass, field corn, or other suitable crop plants. The application of barnyard manure and the plowing under of the organic residues of all crops produced will contribute to the organic matter content of the soil.

Barnyard manures help improve the physical condition of the soil, provide plant nutrients, and increase bacterial activity. Fresh manure should not be applied just before the potato seed is planted. Manures may produce a favorable environment for common scab development, particularly if the soil is near pH 7.0. If large quantities of manure are used, there may be enough salt present to injure young plants.

Liming

Some soils are too acid for successful potato production. These soils can be made more alkaline by the application of lime. Several nutritional problems, such as phosphorus fixation, certain micronutrient deficiencies, and aluminum toxicity are associated with soils that are too acid. In some potato areas, soil acidity is adjusted to about pH 5.0 to 5.4 to control common scab.

It is a good policy to periodically have a soil test to check the soil pH to avoid pH-related problems.

SELECTING, STORING, PREPARING, AND PLANTING SEED POTATOES

Selection of Seed for Planting

Commercial growers should always use seed of known origin and quality as prescribed by the potato certification agency in the area where the seed was grown. Seed labeled as "year from certified" or "year from foundation" does not meet these standards and offers no assurance to the buyer of the seed. Many seed potato certification programs are based on a limited generation system. When an infected seedpiece is planted, not only does the disease reappear in the plant grown from that seedpiece but the entire field is exposed to a source of infection. Seed for planting is satisfactory only if it is an adapted variety, true to name, sound, properly stored, properly sized, and as free as possible from disease and decay.

A grower cannot tell by looking at tubers whether or not they will be good for seed. A grower may get either a favorable or unfavorable impression when he first observes the physical appearance of seed; however, most seed-borne diseases will not be evident until after the crop has started to grow. Seed is now available that has been tested for latent potato viruses. Most certification programs allow varying percentages of the latent viruses, depending on the class of seed stock. Stocks are also being produced by the stem cutting method which has been demonstrated to reduce or eliminate many tuber-borne pathogens. Each grower should know the exact meaning of an area's seed designation before final purchase.

Seed produced under the direction of an official certification program is found chiefly in the northern areas where cooler growing temperatures favor the expression of certain virus disease symptoms and aid in the control of insect vectors that spread diseases. Growers of certified seed potatoes use several methods (tuber unit, hill selection, stem cuttings, limited generation, winter testing) to limit diseases in their seed stock and meet prescribed certification requirements.

Bulk handling and shipping of seed are becoming increasingly popular. Bulk shipments reduce the cost of handling; however, proper suberization, sanitation, and lot identification are essential. All necessary precautions should be taken to maintain lot identity and prevent contamination of the seed. When moving certified seed from the seed grower to the commercial producer either in bulk or in containers, trucks, storage, and handling equipment must be clean and disinfected.

Factors Affecting Seed Performance

Production Management

Attempts have been made to identify the effect of seed source on its ultimate performance. Studies have shown that the planting date and harvest date of a seed crop can influence the production potential the following year. In one study, greater yields were obtained with seed tubers harvested before full maturity and provided with proper storage environment. The lowest yield resulted from tubers harvested from plants killed early (76 days from planting for an early variety and 96 days from planting for a late variety) and the tubers left in the ground five weeks before harvest.

Storage

Storage temperature above 40°F (4.4°C) may promote premature sprouting of seed potatoes, particularly those of varieties with a naturally short rest period. Fluctuation in storage temperature can result in hot spots within a pile of stored seed tubers and can thus reduce seed quality.

Seed stored at temperatures that are too cold may be of lower quality. When tubers of susceptible varieties are exposed for long periods (20 weeks or longer) to a temperature near 32°F (0°C), mahogany browning, an internal reddish brown discoloration, may be found in irregular patches occurring anywhere in the tuber. The boundaries of the discolored areas are irregular and indefinite. Chippewa and Katahdin are examples of susceptible varieties. This phenomenon differs from freezing injury when tubers are actually subjected to freezing temperatures. Tuber flesh with freezing injury usually becomes soft and watery when placed in a warm environment. Either of these conditions, when severe, impairs seed quality. The desired storage temperature for seed potatoes after initial curing is 38-40°F (3.3-4.4°C).

Pre-Plant Warming

Tubers of seed potatoes should be warmed to 50-60°F (10-15.6°C) before handling and cutting. Some 7-14 days before planting the seed should be removed from cold storage. Seed taken from 40°F (4.4°C) storage should never be planted directly. Tubers go through an initial "sweat" period (condensation of moisture on the surface) when changed from a cold to a warm environment and this can contribute to seedpiece decay, particularly with cut seed.

Whole vs. Cut Seed

Many growers prefer to plant uncut, small, seed potatoes. The use of small, uncut seed tubers reduces the hazard of spreading disease in the cutting operation and helps insure a better stand of plants, particularly under adverse field conditions. The desired size range for planting whole tubers without any cutting is 1½ to 2 ounces (Fig. 11). Some growers are reluctant to use small whole tubers because these may be the progeny of virus-infected plants. Use of certified seed which has met winter test standards would reduce this concern. Planting uncut seed tubers frequently results in a heavier set of tubers than that obtained for the same variety when cut seed is planted.

Cut seed, either freshly cut and planted or properly suberized before planting, can be just as productive and healthy as whole seed. Frequently, seed cut and stored before planting will sprout and emerge sooner than whole seed as the cutting operation disrupts apical dominance and allows more sprouts to grow and these sprouts develop more evenly.

The supply of whole tubers for seed is usually limited and often costs more than tubers for cut seed. There are production management techniques that result in a greater yield of small tubers; however, the seed grower can face market problems should the crop not be marketable as seed.

Cutting Seed Potatoes

Several types of mechanical seed cutters are available, all of which do an effective job if managed properly. Machines are available specifically for cutting the round-tuber varieties or for the long-tuber varieties. Some machines can be used to cut both types. Best results are obtained only if the tubers are graded to a uniform size before cutting. Seed cutters should be kept in good repair, the knives sharp and properly adjusted. Every machine should be thoroughly cleaned and disinfected between the cutting of each separate seedlot. Sanitation during the seed cutting and handling operation is essential to reduce disease spread. Periodically, the equipment should be thoroughly cleaned and sanitized, at least daily, even when seedlot changes do not occur, particularly if lots are large. Mechanical cutters rarely eliminate the need for some human labor to remove the slivers and to hand-cut excessively large seed pieces.

Blocky seedpieces are desired (Fig. 12). Cutting of long-tuber varieties in a machine designed or adjusted for round varieties will result in long slender seedpieces with too much cut surface area. A large cut surface provides a greater hazard for seedpiece decay if environmental conditions after cutting are favorable for decay organisms whether it be in storage or in the soil. The desired seed piece is 1½ to 2 ounces (43-57 g) with one to three active eyes. Table 8 gives the average weight of each seedpiece in a 12-pound (5.4 kg) sample. Growers should periodically take samples and check the seed size. When evaluating the sample, also note the number of chips, seedpieces without eyes, and other non-usable seedpieces.

TABLE 8. — *Average weight and corresponding number of seed pieces in a 12-pound (5.4 kg) sample.*

Number of seedpieces in a 12-pound (5.4 kg) sample	Average weight of each seedpiece (ounces)	(grams)
96	2.0	57
109	1.75	50
128	1.50	43
154	1.25	35
192	1.00	28

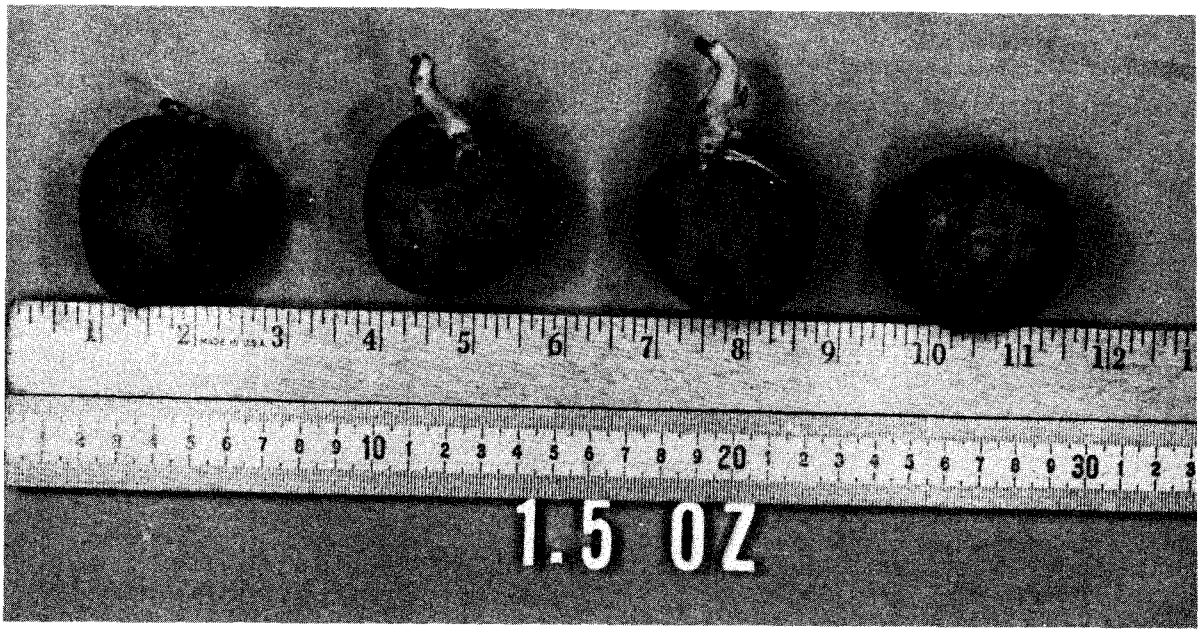

Fig. 11. Sprouted whole seed exhibiting apical dominance. These tubers are of a size preferred for planting whole.
Photo: Cornell

Fig. 12. Ideal cut seed should be large (1.5-2 oz) (43-57 g) and blocky.
Photo: Cornell

Frequently, soil conditions are favorable for suberization or healing of the cut surface so that fresh-cut seed can be planted directly after cutting. Many growers synchronize the cutting operation and the planting operation and thus avoid holding unplanted cut seed. It is safe to cut seed some time ahead of planting provided the tuber pulp temperatures are 50-60°F (10-15.6°C) and storage conditions are provided that allow the cut surfaces to heal. Suberization is best accomplished by: 1) holding the cut seed 3 to 5 days at temperatures of 55-65°F (12.8-18.4°C), 2) maintaining a relative humidity of at least 85 percent; this high relative humidity is required to reduce seedpiece desiccation, and 3) plenty of good ventilation. Failure to provide all three of these conditions can lead to seed decay. Seed which is blocky and well healed is equally as sound as whole seed.

Cut seed should not be exposed to hot sun or wind for even a short time or it will severely shrivel, and decay may result. Covering loads of cut seed with a canvas during transport is recommended. If cut seed must be held without suberization it should be held under conditions described for suberization, if at all possible. When such exact conditions are not available, place in shade, remove tarp, and increase humidity of the holding area. The best place to hold seed for any period when planting is delayed is in a potato storage with good air circulation, high humidity, and temperature control.

Seed should never be put into used fertilizer bags, bulk boxes, or other containers where fertilizer or pesticide residues are present as physical damage to the seed may result.

Removal of Sprouts

Desprouting of seed is sometimes necessary as excessive sprouts will interfere with proper planter operations. Desprouting should be avoided, if possible, because it can reduce vigor and spread disease. If sprout removal is necessary, it should be done only once as repeated sprout removal will adversely affect seed performance. When sprouts are removed, new sprouts will normally appear following a time lag.

A chemical sprout suppressant, tetrachloronitrobenzene (TCNB), is used to retard sprout growth of seed potatoes in some areas and, if properly applied, and the seed is aerated before planting, does not seriously impair seed performance.

Seed Treatment

The need for seedpiece treatment varies from region to region. Numerous studies have been performed to evaluate seedpiece treatment. Seed treatment can only affect disease organisms present on the surface of tubers and does not prevent transmission of virus or growth of bacteria. Most seed treatments are applied as a powder or dust, and there may be some benefit from the drying action on the fresh-cut surface. Protection from invasion of soil borne organisms may result in a reduction of seedpiece decay following planting. Seed treatment is not to be considered as a cure for poor seed handling and for a poor seed environment either before or after planting.

Planting the Crop

Time of Planting

Planting time varies considerably from state to state and region to region and depends on local climatic conditions and intended market use. Growers in the northern areas plant the major portion of their crop in May and early June. In the central states of the U.S. potatoes are planted in April, and in the southern states, planting occurs from November to February. In general, potatoes should be planted when the soil is warm (45°F - 70°F, 7.3°C - 21.1°C) and has

Fig. 13. Semi-mounted potato planters are used widely. Potato planters come in 2, 4, 6 or 8-row units. Picker arm and cup-type planters are the most popular.

Photo: Washington State University

the desired moisture content. Planting in cold, wet soils may contribute to seedpiece decay. Similarly, planting late in hot, dry soils or during humid weather can also contribute to seedpiece decay. Within reasonable limits, the early establishment of the crop results in a greater yield and dry matter potential. In regions where the growing season is longer than is required for full development of the varieties grown, planting dates are selected to provide the crop with the most favorable environment during the critical period of tuberization, proper maturity for the desired market, and economic yields.

Seed Spacing

The variety grown, fertilization program, availability of irrigation, soil type, and market outlet are the major factors determining the desired spacing to use between and within the rows of potatoes. Row widths generally range from 30-36 inches (76-91 cm), although both wider and narrower rows are used. Spacings within the row are influenced most by the intended market and the variety planted. Varieties with a tendency to develop oversize tubers and/or have a small number of tubers set, such as Katahdin or Kennebec, should be spaced at 7-9 inches (18-23 cm) within the row. The closer spacing would apply where irrigation is used or where moisture is not expected to be limiting. Varieties which generally have a heavy set, such as Norchip, should be spaced farther apart in the row, in some areas up to 11-14 inches (28-46 cm). Close spacing in the row in some cases may reduce losses from hollow heart and growth cracks and result in improved appearance and an increase in the number of marketable tubers.

The market outlet is a major determining factor in selecting the proper spacing. Potato processors who produce frozen french-fried products desire large tubers within limits and often pay a premium for a higher percentage of tubers over 10 ounces (284 g). Production of larger tubers is enhanced by wider spacing. The seed market, however, prefers tubers under 3¼ inch (8 cm) diameter or 12 ounces (340 g), and whole B-size tubers often demand a premium.

Depth of Planting

A general practice in the northern regions is to plant 2 to 3 inches (5-8 cm) deep (measured from top of seed piece to ground level) with a total soil cover of only 3 to 4 inches (8-10 cm) to encourage rapid emergence. This results in stronger plants more resistant to attacks by blackleg, rhizoctonia, and seed-piece decay. Ridging or hilling later as the plant develops is usually practiced to enhance stolon development, prevent tuber greening, and facilitate harvest. Where pre-emergence herbicides are used, reduced field operations between planting and emergence will allow weed seeds to germinate and maximize the effect of the herbicide. The ridge or hill is sometimes built up gradually in two or more tillage operations or it may be done in one. Planting depth and soil cover vary from area to area because of soil and moisture conditions and established practices. In some of the lower and flatter areas, it may be desirable to place the seed at levels above that between the rows to protect the seed from surplus water which may stand on the surface because of poor or slow drainage. In the West, or in areas where moisture may be limiting, seedpieces are usually planted from 3-5 inches (8-13 cm) deep to make sure they are covered at all times with moist soil. In some areas, seedpieces are planted six inches (15 cm) deep in preformed beds. Regardless of depth at planting, the seedpiece should ultimately be about 6-8 inches (15-20 cm) below the top of the bed or hill.

Planters

Four general types of potato planters are most frequently used: the automatic picker; the cup type; the assisted feed; and the tuber-unit planter (Fig. 13). The picker planter is the most popular and operates on the principle of forcing nail-like picks into the seedpiece to carry it out of the hopper and then dropping it for planting. The punctures made in the seedpiece can result in the spread of disease and can provide an entry for decay organisms. The picks must be straight, sharp, and properly spaced to obtain desired seedpiece spacing. Picks should be adjusted to the seed size to prevent skips or multiple plantings.

The cup-type planter uses a cup device instead of the pick to convey the seed to the soil, thereby lessening the hazard of disease spread. The seed size must be nearly uniform for optimum results with no skips and a uniform spacing of seedpieces. These planters are well adapted for the use of whole seed.

An assisted feed planter is sometimes used in seed growing operations or with limited acreage. Seedpieces are mechanically fed into a spacing disk before dropping to the soil. Additional labor is needed to place seed in the skipped seed pockets or to remove excess seed pieces and thus prevent multiple plantings.

The tuber unit planter combines the cutting and planting operation. Tubers must be properly sized for best results. The whole tubers are placed in the seed box. A pick transports the tuber to the cutting knife where it is cut into four seedpieces. Each seedpiece is then planted separately. The capacity of this machine is limited and proper sizing of tubers is essential. Disinfecting equipment can be added to reduce disease spread.

Amount of Seed to Plant

The amount of seed needed to plant an acre varies according to seed piece size, row, and plant spacing. Table 9 shows the seed required for several spacings and seed piece sizes. Growers should strive for plant populations that are optimum for their area, growing conditions, and variety.

TABLE 9. — *Seed potatoes required to plant an acre at different spacing with seed pieces of various weights.*

Spacing of rows and of seedpieces within rows	Seed required per acre when seedpieces weigh an average of —		
	1½ oz (43 g)	1¾ oz (50 g)	2 oz (57 g)
	cwt or (kg)		
Rows 30 in (0.76 m) apart			
6 in (15.2 cm)	32.6 (14.8)	38.0 (17.2)	43.6 (19.8)
8 in (20.3 cm)	24.5 (11.1)	28.6 (13.0)	32.6 (14.8)
10 in (25.4 cm)	19.6 (8.9)	22.8 (10.3)	26.1 (11.8)
12 in (30.5 cm)	16.3 (7.4)	19.0 (8.6)	21.8 (9.9)
14 in (35.6 cm)	14.0 (6.4)	16.4 (7.4)	18.7 (8.5)
Rows 32 in (0.81 m) apart			
6 in (15.2 cm)	30.7 (13.9)	35.9 (16.3)	40.9 (18.6)
8 in (20.3 cm)	22.9 (10.4)	26.8 (12.2)	30.6 (13.9)
10 in (25.4 cm)	18.4 (8.3)	21.4 (9.7)	24.5 (11.1)
12 in (30.5 cm)	15.4 (7.0)	17.9 (8.1)	20.5 (9.3)
14 in (35.6 cm)	13.1 (5.9)	15.2 (6.9)	17.5 (7.9)
Rows 34 in (0.86 m) apart			
6 in (15.2 cm)	28.8 (13.1)	33.6 (15.2)	38.4 (17.4)
8 in (20.3 cm)	21.6 (9.8)	25.2 (11.4)	28.8 (13.1)
10 in (25.4 cm)	17.3 (7.8)	20.2 (9.2)	23.0 (10.4)
12 in (30.5 cm)	14.4 (6.5)	16.8 (7.6)	19.2 (8.7)
14 in (35.6 cm)	12.4 (5.6)	14.4 (6.5)	16.5 (7.5)
Rows 36 in (0.91 m) apart			
6 in (15.2 cm)	27.1 (12.3)	31.7 (14.4)	36.1 (16.4)
8 in (20.3 cm)	20.4 (9.3)	23.8 (10.8)	27.2 (12.3)
10 in (25.4 cm)	16.3 (7.4)	19.0 (8.6)	21.8 (9.9)
12 in (30.5 cm)	13.5 (6.1)	15.8 (7.2)	18.1 (8.2)
14 in (35.6 cm)	11.6 (5.3)	13.6 (6.2)	15.5 (7.0)

GROWING THE CROP

Many things affect crop growth from the time of planting until harvest. These include fertilization, cultivation, rainfall and/or irrigation, and weed, insect, and disease control.

Cultivation

The purpose of cultivation includes maintaining proper soil aeration, shaping beds to allow space for maximum tuber growth and to prevent sunburning, establish irrigation furrows, and control weeds. If a cultivation operation does not accomplish one of these purposes, the operation is a waste of effort.

The kind and amount of cultivation will depend on the planting method, kind and severity of weed infestation, irrigation method used and, to a lesser extent, the potato variety grown.

If the potatoes are planted in such a manner as to leave the field quite flat, one or more post-planting bed shapings, or hillings may be necessary. If the potatoes are planted into pre-made beds, or if beds are formed at planting time, one post-planting bed shaping operation may be the only cultivation necessary.

The implements used for bed shaping vary considerably. Disks, winged cultivator teeth, hilling "spades" or listers, and rolling cultivators, when used properly can shape acceptable beds (Fig. 14). No matter which type of cultivating or hilling implement is used, tillage should not take place in wet soils. Working soils that are wet results in compaction and forms clods that will present problems at time of harvest.

Working the ground to aerate the soil should be practiced only if the grower is certain the benefits from aeration will more than offset the compaction in the furrows that results from the operation.

Some varieties tend to set tubers higher in the beds than others. To prevent sunburning, additional soil may be required to cover the tubers. However, late cultivation can also be harmful due to root and stolon pruning.

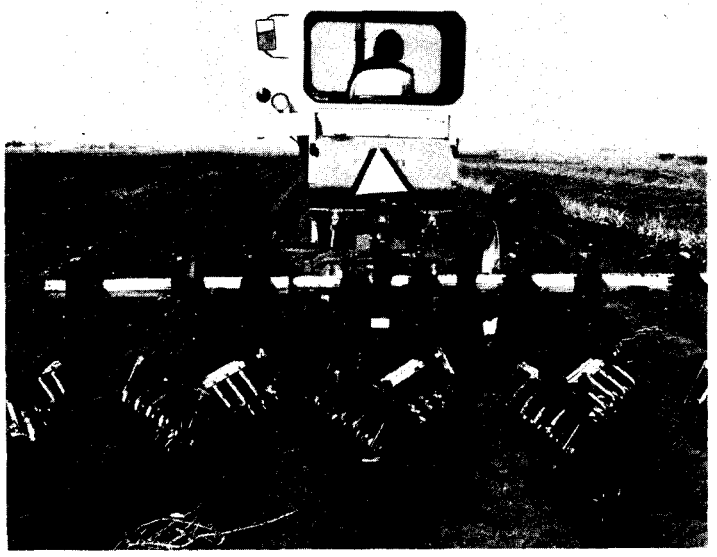

Fig. 14. A rolling cultivator bed-shaping implement. Multirow equipment allows for handling large acreage on a more timely basis.

Cultivation can be a very effective method of weed control. The principal benefits come from post-plant, pre-emergence cultivation to kill early weeds and cultivation during the first 30-40 days after emergence to control weeds in the furrows and on the sides of the beds. Thereafter, shading and herbicides must be depended upon for weed control.

Water Requirement and Irrigation

Water management and/or lack of adequate rainfall are probably the most important factors determining yield and quality of potatoes. Knobby tubers, growth cracks, internal necrosis, blackspot, hollow heart, heat sprouting, and other disorders are directly related to amount and distribution of water during the growing season. Diseases such as seed piece decay, rhizoctonia stem canker, and late blight can also be related to amount and distribution of water. Factors to consider are method of applying water (rainfall, sprinkler irrigation or furrow irrigation), timing of irrigation, and quantity of irrigation.

Specific guidelines for irrigation cannot be given here because of the wide diversity of rainfall, temperature, and soil conditions under which potatoes are grown in the United States and Canada. State and local agencies must be relied upon for these specific guidelines. Many general guidelines are pertinent to all potato producing areas, however.

In the eastern one-half to two-thirds of North America most of the potato producing areas receive substantial amounts of rainfall during the growing season. Most of the areas in the western one-third to one-half, except the northernmost coastal areas, must rely upon some type of irrigation.

While the amount of water required to permit optimum growth of potatoes varies somewhat with variety, humidity, sunlight, and length of growing season, the seasonal requirement for varieties in all areas will be at least 18 acre-inches of water. It may be as much as 30-36 acre-inches of water in some areas. Where irrigation is practiced, the soil profile should be at or near field capacity at the beginning of the season and additional water supplied to the plants in frequent, light amounts during the growing season.

For irrigation management decisions, it should be remembered that: 1) the effective rooting depth of potatoes is 2 ft (60 cm), 2) the soil should not be allowed to dry below 65 percent of field capacity, 3) moisture levels above field capacity will seriously affect yield and quality, and 4) soil types can vary threefold in their respective water holding capacities.

Studies in several different growing areas have shown that daily water needs increase linearly until about two weeks after maximum row coverage is achieved. From this time on the plants' daily water requirement holds nearly constant until the vines begin to mature (cast off), at which time water requirement declines.

The amount and rate of water that should be applied during any given irrigation depend on the infiltration rate and water holding capacity of the soil, in addition to the amount of water already in the soil and the stage of plant growth, including depth of rooting. In

sandy soils, the application of more than two inches of water will result in leaching of nutrients below the plants' root zone, while in heavier textured soils four to five inches of water can be applied without leaching. The amount of runoff can be minimized, if not eliminated, by accurate determination of infiltration rate and adherence to the practice of not applying the water faster than the soil can absorb it.

Where rainfall is a major source of water, efficiency can be improved by not planting on steep slopes, by properly preparing the soil so infiltration is enhanced, and by forming small ridges periodically in furrows to slow the water running down the furrows.

Where irrigation is used, several choices of methods are usually available. The most common include furrow irrigation, solid set sprinklers, wheel line sprinklers, hand-move sprinkler systems, circular overhead sprinklers, and sub-irrigation.

Sub-irrigation is a method used in peat-like soils and/or where the water table is easily raised. For this to be a suitable method, fields must be relatively level and soils uniformly porous. Otherwise, excessively wet and excessively dry areas will occur in the same field.

Furrow irrigation can be efficiently and effectively used where the field does not have much slope (0-2%) and where the length of rows is not long [600-800 feet (182-244 m)]. Care must be taken to ensure that the water is not applied faster than the soil can absorb it. Uniform application from one end of the row to the other is more difficult to achieve with this method than with sprinkler irrigation methods.

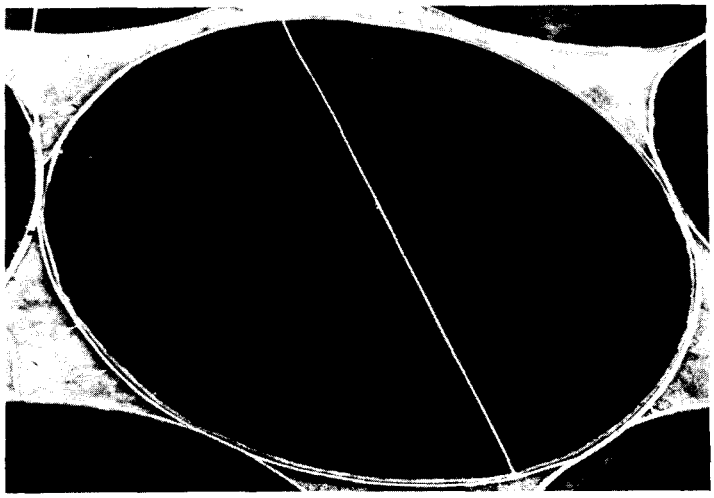

Fig. 15. Large center pivot or "circle" sprinkler irrigation system widely used for potato irrigation. Acreage covered by each unit varies from as small as 20 acres to over 200 acres.

Sprinkler irrigation systems provide the most flexibility and the best opportunity for efficient water application (Fig. 15). Fields need not be flat and application rates can be easily adjusted through nozzle size, pump pressure, and spacing of nozzles. They also increase versatility through applications of some fertilizers and pesticides. They are, of course, considerably more expensive than furrow irrigation systems; but, many studies have proven their economic advantages. Today, most of the irrigated acreage of potatoes in North America is by one of the sprinkler systems; and, the highest yielding areas and fields within given areas are almost always under sprinklers.

Fertilizers

Importance

Most soils require the addition of one or more of sixteen essential elements to produce satisfactory yield and quality of potatoes.

Numerous research and demonstration plots have shown the importance of supplying fertilizer nutrients to the potato crop. It is not uncommon to increase production of potatoes by 200-300 cwt/acre (22.4 - 33.6 t/ha) by adding one or more of the essential nutrients. The total amount and balance of the essential elements in the soil are important. Applying a complete fertilizer mix without considering nutrients already present in the soil may result in over-fertilization of a particular element and possible crop injury as well as a waste of money and resources.

Potatoes remove large quantities of nutrients from the soil, depending on amount of vine growth and tuber yield. A direct relationship exists between tuber yield and nutrient removal. As the yield per acre increases, nutrient removal increases in a linear manner, with a 600 cwt/acre (67.2 t/ha) yield, removing twice the amount of nutrients as a 300 cwt/acre (33.6 t/ha) yield. Since vine growth varies considerably within areas having similar tuber production, correlation between vine yield, nutrients removed, and tuber yield is poor. Average values for nutrient removal by the Russet Burbank potato are listed in Tables 10 and 11.

TABLE 10. — *Amount of nutrients removed from the soil by potato tubers*.*

Nutrient	lb/100 cwt	kg/454 kg	Removed by 500 cwt/acre lb/A	(56 t/ha) kg/ha
Nitrogen	30.0	13.6	150	168
Phosphorus (P_2O_5)	7.0 (16)	3.2 (7.3)	35 (80)	39 (90)
Potassium (K_2O)	44.0 (53)	20.0 (24.0)	220 (264)	246 (296)
Calcium	0.8	0.4	4.0	4.5
Magnesium	2.5	1.1	12.5	14.0
Sulfur	2.4	1.1	12.0	13.4
Zinc	0.02	0.01	0.10	0.11
Copper	0.016	0.007	0.08	0.09
Manganese	0.015	0.007	0.08	0.09
Iron	0.047	0.021	0.24	0.27
Boron	0.007	0.003	0.04	0.04

*Source: R. Kunkel, Washington State University

TABLE 11. — *Amount of nutrients removed from the soil by potato vines*.*

Nutrient	Top growth, September 1 lb/A	kg/ha
Nitrogen	139	156
Phosphorus (P_2O_5)	11 (25)	12 (28)
Potassium (K_2O)	275 (330)	308 (370)
Calcium	43	48
Magnesium	25	28
Sodium	2.70	3
Zinc	0.11	0.12
Manganese	0.17	0.19
Iron	2.21	2.48
Copper	0.03	0.03
Boron	0.14	0.16

*Source: C. G. Painter, University of Idaho

Although some variation among varieties may exist on nutrient removal, these values can be used to estimate nutrient removal by potatoes in most areas.

The availability of nutrients in individual soils from different areas is influenced by soil development, crop rotation, fertilizer use, irrigation water, and crop residues returned. Therefore, only general information on potato fertilization will be given. Local advice in soil fertility problems is available through university and/or government offices.

Kind and Amount

Fertilizer recommendations based on plant and soil analyses are the best means of arriving at a sound soil fertility program. Emphasis should be placed on use of soil tests that have been calibrated for the specific areas where the potatoes are being grown. A history of petiole analyses taken during the growing season, coupled with soil analyses, will provide the most accurate prediction of fertilizer needs for a specific field. A history of production level compared to changes in soil nutrient levels as determined from soil samples can also be a useful management tool.

Soil and plant testing services are available through university, government, or commercial laboratories. Laboratories in your growing region will give the most desirable results. Laboratory methods and/or interpretation of results in one area may have little value in diagnosing nutrient needs for potatoes grown in another area.

Nitrogen fertilizer will be needed on most soils to produce a profitable yield of potatoes. Soils having a high amount of nitrate nitrogen in the soil from previous fertilizer application, green manure crops such as alfalfa, peat or muck soils, and where high rates of livestock manure have been applied in the rotation will require less fertilizer nitrogen than other soils. Excess nitrogen levels decrease tuber quality, grade, and yield.

Phosphorus fertilizer will also be needed on most soils to produce a good crop of potatoes. Soil analysis can generally be used to identify large amounts of residual phosphorus from past fertilizer use and indicate where phosphorus may not be needed for the present crop.

Potassium is required on many soils but this need varies considerably. Cropping practices, past fertilizer use, soil parent material, and source of irrigation water are the main factors affecting the need for potassium fertilizer. In some areas, 10-40 pounds (4.5-18 kg) of potassium per acre-foot of irrigation water are being applied along with other nutrients such as nitrogen, sulfur, magnesium, and calcium.

Supplemental calcium and magnesium will be needed in some acid soils where leaching of nutrients has occurred. Soil analysis can usually identify these needs. Sulfur is frequently required where irrigation waters do not contain large amounts of this nutrient, where soils are naturally low in sulfur, and where sulfur has not accumulated from previous applications.

Zinc and manganese may be needed in some soils such as the calcareous, alkaline soils in the Northwest. Boron, iron, and copper levels in soils are usually sufficient in most potato growing areas. Certain mucks and peats may be deficient in copper.

The amount of nutrients needed to be applied as commercial fertilizer will depend not only on the level of available nutrients in the soil but on the potential yield as governed by such factors as: variety, seed spacing, moisture, climate, diseases, and insects. On some low fertility soils where 400-600 cwt/acre (44.8 - 67.2 t/ha) of potatoes are produced, 200-400 pounds each of N, P_2O_5, and K_2O/acre (224 - 448 kg/ha) are used. In areas having a short growing season, low moisture, and yields of 150-200 cwt/acre (16.8 - 22.4 t/ha) only 40-60 lbs/acre (44.8 - 67.2 kg/ha) of N are removed by the tubers. If higher than optimum rates of any of these are applied, a buildup of residual nutrients would occur.

Fig. 16. Broadcast fertilizer equipment is used in some areas to apply liquid or dry fertilizer prior to planting.

Photo: Washington State University

Micronutrients such as zinc and manganese may be applied to soil with other fertilizer. Rates of 5-10 lbs/acre (6 - 11 kg/ha) of zinc should be sufficient to take care of three years' production of potatoes.

Plant analysis is used in many potato producing areas to diagnose nutrient needs or deficiencies during the growing season. Plant analysis is an excellent tool to use in diagnosing potato problems. A comparison between healthy and unhealthy plants will help determine if the problem is a nutrient deficiency.

Source

The common forms of nitrogen fertilizer are, nitrate, urea, and ammonium. Potato plants can utilize either the nitrate or ammonium form in the soil. The nitrate form is more subject to leaching, thus in irrigated areas where an occasional heavy rainfall occurs, or in heavy spring rainfall areas, pre-plant or planting time applications of ammonium nitrogen will probably be most efficient. Post-plant nitrogen applied through overhead irrigation systems should be in the nitrate and/or urea forms, since they are less damaging to the irrigation equipment than is the ammonium form.

All of the common carriers of phosphorus fertilizers give satisfactory results in potato production. These include treble super phosphates and ammonium phosphates.

Potassium is usually supplied as either potassium sulfate or potassium chloride. Some evidence supports the use of sulfates, as chloride appears to reduce specific gravity and produce lighter colored skins on tubers of russet varieties than does the sulfate form.

Zinc and copper can be applied as sulfates or as chelates. Manganese should be applied as sulfate. Calcium and magnesium are available as carbonates and sulfates. Sulphur can be applied in elemental form or as a sulfate.

Time and Method of Application

As a general rule, fertilizer applied more nearly to time of plant need is used most efficiently. However, time of fertilizer application and placement are also a matter of personal preference, convenience, and the availability of materials and equipment.

Part of the nitrogen and all of the other fertilizer nutrients should be applied at or before planting. If leaching is not a potential problem, all of the nitrogen can be applied pre-plant with the other nutrients. Phosphate, potassium, and zinc fertilizer can be effectively applied in the fall in some areas where spring planting is practiced. Banding of ammonium nitrogen will increase the uptake of phosphate, zinc, and manganese. This can help correct deficiencies on some calcareous soils but can accentuate manganese toxicity in acid soils.

Pre-planting broadcast fertilizer applications have the advantage of more rapid application and the elimination of fertilizer handling during the planting operation — thus full time can be devoted to the potato planting itself (Fig. 16). Discing or folding fertilizer into the planting beds should immediately follow broadcast applications. Broadcast applications are not satisfactory where soil fixation of nutrients occurs, where the fertilizer is subsequently plowed below the level of greatest root density, where root restriction prevents nutrient uptake from the area where the fertilizer has been incorporated, or where leaching can occur after application.

Nitrogen can be applied with irrigation water or mechanically side dressed during the growing season. Petiole analysis during the early stages of growth can be used as a basis for adjusting N applied during the growing season to meet the plants' need. Nitrogen should not be applied late in the growing season. Charts showing optimum levels of nitrate-nitrogen in petioles at different stages of growth are available in some areas.

Irrigation management, weed, insect, and disease control significantly influence the response to fertilizer applications and the ultimate crop yield. Over-irrigation and nitrogen leaching are hazards on sandy soils. Under these circumstances high rates of nitrogen or midseason applications may be required to supply the crop's needs. A heavy weed population will compete for fertilizer nutrients with growing potatoes and result in reduced yield. Unhealthy potato plants due to either disease or insects will not be able to take full advantage of optimum fertilizer levels, therefore both disease and insect control programs affect response of potatoes to fertilizer application.

Weed Control

An effective weed control program takes into account the primary weed problem, cultivation, available herbicides, and competitive ability of potato varieties. Although weed problems can be quite specific to given production areas, they can be categorized into three main classes: broad-leaved annuals, annual grasses, and perennials. Broad-leaved annuals, with the exception of nightshade (*Solanum nigrum* L.), are the easiest to control. An application of a pre-emergence herbicide and/or cultivation as the weeds are germinating and emerging provides effective early season control. The most widely distributed broad-leaved weeds of concern in potato fields are: lamb's-quarters (*Chenopodium album* L.), red root pigweed (*Amaranthus retroflexus* L.), ragweed (*Ambrosia artemisiifolia* L.) and smartweed (*Polygonum pensylvanicum* L.). Annual grasses such as barnyard grass (*Echinochloa crusgalli* [L.] Beauv.), foxtail (*Setaria* sp.), and fall panicum (*Panicum dichotomiflorum* Michx.) germinate later than most broad-leaved annuals. Because of the later germination, a pre-emergence herbicide with residual activity or an effective herbicide that can be applied after potato emergence, is needed for control of these weeds. Potato varieties that develop and maintain a dense canopy when grasses are emerging are also beneficial in controlling these weed pests. The most difficult weeds to control are the perennial weed species. The major perennial problem weeds include nutsedges (*Cyperus* sp.), quackgrass (*Agropyron repens* [L.] Beauv.), and Bermuda grass (*Cynodon dactylon* [L.] Pers.). In addition to causing yield reduction and decreasing harvest efficiency, rhizomes of perennial grasses and nutsedges can penetrate potato tubers causing severe reduction in quality. When perennial weeds are the primary problem, more than the standard number of cultivations may be needed for effective weed control, even though herbicides are used. The additional cultivations can enhance the effect of the herbicides by weakening the perennial weeds. Care should be taken not to spread weed rhizomes from infested to noninfested fields.

If herbicides are used, the choice of which one or ones to use must be tailored to the kinds of weeds present and when these weeds germinate. The method and rate of application should be in accordance with the manufacturer's label and local recommendations (Fig. 17).

Fig. 17. The use of appropriate herbicides at the proper timing and rates can help control weeds. **Photo: Cornell**

Methods of application vary from pre-plant soil incorporation, post-plant but pre-emergence, to post-emergence applications. Various herbicides can be applied by ground rig, airplane, or through the sprinkler irrigation system.

Specific herbicides, rates and methods of applications vary throughout the United States and Canada. Most agricultural universities regularly publish specific recommendations for each area. Consult your local pest control advisor and/or government office for specific recommendations.

Insect Control

The control of insects is an important consideration in production management. A large number of insect pests attack potatoes and cause yield and/or quality reduction. Specific control measures for insects should be obtained from a local source.

Specific insect problems vary with production area. However, there are several insect pests that cause varying amounts of damage in most producing areas. Aphids are an example. In addition to direct feeding damage attributable to these insects, the indirect damage, through the spread of potato virus diseases, is more serious. See Table 12 for an understanding of the large number of diseases that are aphid-transmitted. The virus content of seed tubers is especially critical since infected tubers do not produce healthy sprouts and the yield potential of diseased plants can be greatly reduced. Potato leaf roll virus can, in susceptible varieties, also cause tuber net necrosis which makes them unmarketable. Net necrosis is an internal discoloration and is not visible during grading. Aphid control measures include: chemical control, both systemic and contact; the eradication of overwintering host plants such as peach, plum, and other *Prunus* species; control of weed hosts such as yellow and jimhill mustard; and monitoring of potted nursery plants and flowers to assure that they are aphid-free. Control of aphids does not insure control of potato viruses; but virus control is not feasible without aphid control.

Leafhopper species belong to another group of sucking insects which have wide distribution. These widge-shaped insects feed on the potato plants and secrete a toxic substance in the process. Feeding of high leafhopper populations will cause a condition known as hopperburn. Characteristic symptoms are an upward curling of the tips and margins of leaves which first appear yellow and then dry to a brown discoloration. Leafhoppers are also vectors of some diseases, such as purple top wilt, witches broom, and curly top (Table 12).

The most destructive, foliage-eating, potato insect is the Colorado potato beetle (*Leptinotarsa decemlineata* [Say]). Both adults and larvae feed on potato foliage, but the larval stage is more destructive. If populations are not controlled, leaves will be stripped, leaving only the stalks. The adults are oval-shaped, hard-shelled, yellowish beetles with black stripes down the back. The larvae are initially red in color but turn orange as they grow. Two rows of black spots are prominent on the larvae (Fig. 18).

Flea beetles can cause foliar damage to potato plants. Feeding of flea beetle adults appears as small irregular to round holes in potato leaves. The larval stage of the tuber flea beetle, (*Epitrix tuberis* Gentner), feeds on tubers and can cause a serious reduction in quality. Flea beetle adults are shiny black, small insects that move rapidly when disturbed.

Other insects causing severe tuber defects are potato tuber worm, *Phthorimaea operculella* (Zeller), and wireworms. The potato tuber worm is primarily a problem in southern producing areas but can be a problem in warm storages in northern states. Even though the larvae cause damage to the growing plant by burrowing in the stems or mining the leaves, the most serious damage is to the tubers. Affected tubers are unsaleable because of the tunnels made by the larvae. Since eggs are laid on tubers, one means of control is to keep tubers from being exposed to the egg laying moths. Proper hilling practices, sprinkler irrigation to prevent soil cracking, and placing tubers in storage or under cover immediately after digging are cultural methods that help control the pest. Chemicals for control of the moths are also available.

Fig. 18. Colorado potato beetle: Adults, larvae, and injury to potato.

Photo: University of Maine

Wireworms are larval forms of click beetles. Wireworms are descriptively named since they have wire-like bodies which are jointed and have a brownish color. The larvae feed on developing tubers causing numerous, pencil-point width holes that range in depth from just below the surface to the center of the tubers. Proper crop rotation and pre-plant or planting time applications of approved insecticides are method of control.

Numerous other insect pests cause damage to potatoes. Many are specific to certain growing areas. Information on insect pests and control measures for a given region should be obtained from the agricultural authorities in that region.

Disease Control

Numerous potato diseases and disorders are encountered by growers each year. These diseases may be caused by bacteria, fungi, viruses, mycoplasms, or may be physiological in nature. Nematodes can also be destructive either by themselves or as vectors of certain viruses.

Table 12 lists the most common diseases and disorders encountered by growers in the United States and Canada; the causal organism; whether it affects the vine, tuber, or root; the most common method of spreading the source of disease from one year to the next; and a brief comment on control.

While prevention and control of the many diseases affecting potatoes vary widely depending upon the specific disease, some practices apply generally to all diseases. These include the following:

1. Use certified seed.
2. Handle seed properly.
3. Follow a regular and rigorous sanitation program.
4. When applying fungicides, follow the instructions on the label as well as the local authorities' recommendations.
5. Irrigate uniformly and adequately, but not excessively.
6. Control aphids, leafhoppers, and nematodes.
7. Harvest and handle tubers gently.
8. Do not harvest when tuber temperatures are below 45°F (7°C) or above 85°F (30°C).
9. If storing, provide environment for wound healing, followed by proper temperature, humidity, and aeration.
10. Warm cold tubers in storage before handling.

TABLE 12. — *Reference table of some potato diseases and physiological disorders.*

Name	Causal Organism	Part of Plant Affected	Means Of Spread	Source Of Innoculum	Control
Bacterial Brown Rot (Southern Bacterial Wilt)	Bacterium (*Pseudomonas solanacearum*).	Tubers	Soil and seed	Soil and seed	Avoid infested fields
Bacterial Soft Rot	Bacterium (*Erwinia carotovora*)	Tubers	Soil and contact	do---	Allow tubers to suberize after harvest; dry washed potatoes; minimize wounding
Blackheart	Physiologic	do---	None	None	Store at temperatures below 70°F (21°C) with proper ventilation
Blackleg	Bacterium (*Erwinia carotovora* var. *atroseptica*)	Tubers and stems	Seed, soil, & mechanical	Seed, (soil)	Use disease-free seed; prevent wounding; treat and suberize seed pieces, warm seed; sanitize
Calico	Virus (alfalfa mosaic)	Vines and tubers	Aphids & seed	Seed, alfalfa, clover	Eliminate "volunteer" alfalfa plants; use disease-free seed; control aphids.
Corky Ring Spot	Virus (tobacco rattle)	Tubers	Nematodes	Soil & seed	Avoid infested fields; use resistant varieties; control nematodes.
Crinkle Mosaic	Virus (Potato Virus A + X)	Vines & tubers	Aphids, seed, & mechanical	Seed	Disease-free seed, resistant varieties, control aphids, sanitation.
Dry Rot	Fungus (*Fusarium* spp.)	Tubers	Soil & tubers	Soil & seed	Prevent wounding at harvest, treat tubers with fungicide, allow tubers to suberize and then store at low temperatures.
Early blight	Fungus (*Alternaria solani*)	Vines & tubers	Air & water	Soil; plant debris	Spray with fungicides; practice crop rotation and sanitation.
Enlarged lenticels	Physiologic	Tubers	Not transmitted.	None	Promote soil aeration and drainage. Don't over-irrigate.
Fusarium Wilt	Fungus (*Fusarium solani* var. *eumartii and F. oxysporum*)	Vines & tubers	Soil & seed	Soil & seed	Use disease-free seed; practice crop rotation.
Growth Cracks	Physiologic	Tubers	Not transmitted	None	Use resistant varieties; keep soil moisture optimum and uniform.
Haywire	See purple-top wilt				
Heat sprout	Physiologic	Tubers	Not transmitted	None	Use resistant varieties; provide adequate moisture.
Hollow heart	do---	do---	do---	do---	Space plants closer in rows; use resistant varieties; provide uniform moisture.
Internal Blackspot	do---	do---	do---	do---	Reduce harvest and grading bruises; prevent potassium deficiency; keep soil moist prior to harvest; high humidity storage.
Internal or heat necrosis	do---	do---	do---	do---	Use nonsusceptible varieties; provide adequate soil moisture
Internal sprouting	Physiologic	do---	do---	do---	Do not store at excessively high temperatures. Proper aeration in storage.
Jelly-end rot	do---	Tubers (especially long ones)	do---	do---	Provide uniform and adequate soil moisture
Late Blight	Fungus (*Phytophthora infestans*)	Vines & tubers	Air, water & seed	Seed; cull piles; volunteers	Use resistant varieties and disease-free seed; spray with fungicides; eliminate cull piles; kill potato foliage 10 days to 2 weeks before digging.
Latent Mosaic	Virus (potato virus X)	Vines	Mechanical & seed	Seed	Use resistant varieties or disease-free seed; sanitation
Leaf roll	Virus (potato leaf roll)	Vines & tubers (net necrosis)	Aphids & seed	Seed (minor weed hosts)	Use disease-free seed; control aphids; use resistant varieties; rogue diseased plants; isolate from other potatoes.
Leak	Fungus (*Pythium debaryanum*)	Tubers	Soil	Soil	Prevent harvest injury; suberize in storage; cool tubers to 40° - 45°F soon after harvest; avoid poorly drained soils.
Mahogany browning	Physiologic	do---	Not transmitted	None	Store at 40°F or above.
Mild mosaic	Virus (potato virus A)	Vines & tubers	Aphids & seed.	Seed	Use disease-free seed or resistant varieties; control aphids; rogue diseased plants early.
Nematode (eelworm) diseases	Nematodes:				Fumigate or treat soil with nematicides; rotate crops or fallow fields; prevent movement of material from infested fields; use nematode-free seed; use resistant varieties. For golden nematodes, observe quarantine regulations.
	Golden (*Globodera rostochiensis*)	Roots	Soil & tubers	Soil, seed, & equipment	
	Potato tuber rot (*Ditylenchus destructor*)	Tubers	Soil	Soil	
	Root knot (*Meloidogyne* spp)	Tubers & roots	Soil & tubers	Soil & seed	

TABLE 12. — *(Cont.)*

Name	Causal Organism	Part of Plant Affected	Means Of Spread	Source Of Innoculum	Control
	Root lesion, or Meadow (*Pratylenchus penetrans*)	Tubers & roots	Soil	Soil	
Net necrosis	See leaf roll				
Psyllid yellows	Insect (*Paratrioza cockerelli*)	Vines & tubers	Insect (Psyllids)	Seed & weed hosts	Control psyllids.
Purple-top wilt (haywire)	(aster yellows) Mycoplasm	do---	Insects (leaf-hoppers)	Crop & weed hosts	Control leafhoppers.
Rhizoctonia	Fungus (*Rhizoctonia solani*)	Stems, tubers, & roots	Soil & seed	Soil & seed	Treat seed tubers; avoid planting in cold soils; disease-free seed.
Ring rot	Bacterium (*Corynebacterium sepedonicum*)	Vines & tubers	Mechanical & seed	Seed, equipment & storage	Plant disease-free seed; use whole seed; disinfect storages and equipment.
Rugose mosaic	Virus (potato virus Y + X)	Vines	Aphids, seed, mechanical	Seed (minor weed hosts)	Plant disease-free seed; control aphids; use resistant varieties; rogue diseased plants early, sanitation.
Scab, common	Fungus (*Streptomyces scabies*)	Tubers	Soil & seed	Soil & seed	Avoid infested fields; use resistant varieties; rotate crops; treat seed; control pH; maintain uniform moisture.
Scab, powdery	Fungus (*Spongospora subterranea*)	Tubers roots	do---	do---	Avoid infested fields; use disease-free seed; rotate crops.
Second growth	Physiologic	Tubers	Not transmitted	None	Provide adequate and uniform soil moisture; use resistant varieties.
Silver scurf	Fungus (*Helminthosporium solani*)	Tubers	Soil & seed	Soil & seed	Use disease-free seed; practice crop rotation; resistant varieties.
Soft Rot (See bacterial soft rot)					
Southern bacterial wilt (See bacterial brown rot)					
Spindle tuber	Viroid (potato spindle tuber)	Vines & tubers	Seed & mechanical	Seed	Use disease-free seed; reduce machinery use in fields after plants emerge.
Stem-end vascular browning	Wilt fungi & vine killers	Tubers	Dependent on cause	Dependent on cause	Control wilt diseases; apply vine killers properly
Verticillium wilt (early dying)	Fungus (*Verticillium* spp.)	Vines & tubers	Soil, seed & debris	Soil, seed & other crop debris	Fumigate infested soil; use resistant varieties; practice long rotations; plant disease-free seed.
Wart	Fungus (*Synchytrium endobioticum*)	Tubers	Soil	Soil	Do not plant in infested fields; Resistant varieties.
Yellow dwarf	Virus (potato yellow dwarf)	Vines and tubers	Seed leaf-hoppers, & mechanical	Seed & clovers	Use disease-free seed; control leafhoppers; avoid clovers in rotation.

HARVESTING THE CROP

Since potatoes are grown to some extent in all states in the United States and all provinces of Canada, they are harvested every month of the year and probably every day. In some areas, potatoes are harvested while vines are still green and tubers comparatively immature. Such potatoes usually go directly to the fresh market or into processing. This is especially true in the early producing areas — those designated as winter, spring, and summer.

The fall crop is harvested when more mature. However, the use of better production techniques and improved pesticides tends to delay maturity to a point where potatoes in many so-called late producing areas are not mature at harvest time. Mature potatoes are usually higher in dry matter which makes them of better quality for most processing markets. They also have tougher skins which will resist skinning and bruising during the harvesting operation. Excessive skinning not only spoils appearance, but it also predisposes tubers to bacterial and other rots and results in weight loss in storage.

In general, it is desirable to have vines dead and dried up before harvest, especially where potatoes are to be stored for some time.

Vine Killing

Vine killing does not necessarily improve maturity from the standpoint of internal quality (dry matter) but will help in "skin set" and reduce bruising. Internal quality must be "built-in" to the crop at harvest time through the proper production techniques.

Years ago, potato vines died and dried up from various causes before harvest. Insect damage, lack of fertility, or decreased moisture were often responsible for killing vines. Late and early blight diseases contributed to the killing of vines in many fields well in advance of harvest.

In recent years, new pest control materials and practices reduce the insect and disease effects on potato plants. Better irrigation practices and higher fertilizer rates also contribute to maintaining green vines later into the season. The improvement in these and other cultural practices has resulted in increased yields and has enhanced the economics of potato production. It also has made it necessary to include the practice of vine killing in preparation for harvest (Figure 19).

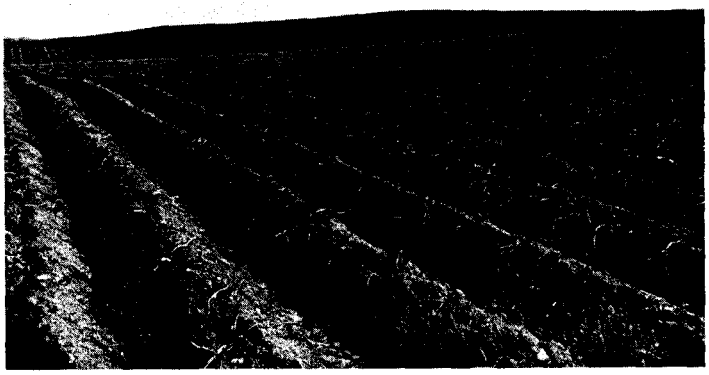

Fig. 19. An effective vine kill improves harvest efficiency, helps "mature" tubers and controls certain diseases.

Vine killing is not without disadvantages. It is costly, difficult to accomplish, and sometimes adversely affects internal quality of the tubers. However, harvesting potatoes without vine killing in some areas can be disastrous.

In humid areas where late blight is a problem, green vines at harvest can mean rotten potatoes in storage. Spores of the late blight organism can be present on green vines and enter the tubers through skinned and bruised areas during the harvesting operation. In storage, the spores grow, causing tubers to break down. The rot caused by late blight is dry, but usually turns soft due to the entrance of bacteria. Many bins of potatoes are lost each year from late blight rot. Infection does not have to be readily apparent in the vines. It takes only a few late blight lesions to produce thousands of spores. A few lesions are hard to see in a potato field. The safest precaution is to have potato vines dead and dry at harvest time.

Timely vine killing tends to toughen skins of tubers so they can be harvested with a minimum of skinning and bruising. The bruised and skinned areas give potatoes a poor appearance on the fresh market and increase waste and costs for the processor.

There are several other reasons for vine killing. Harvesting is easier when vines are dead. Under some conditions, vine killing is necessary to control tuber size. This can be important to seed growers as well as for those selling in other markets. Early vine killing is often necessary in the seed crop to prevent the spread of leaf roll and other virus diseases by a late infestation of aphids.

In late producing states, frost sometimes takes care of the vine killing — especially during the late part of the harvest season; but during the early part of the harvest, artificial killing of the vines may be essential. The length of time required between killing and having vines dead and dry will depend upon many factors.

If soil moisture is high or if vines are green, large, and vigorous, they will be difficult to kill and require more time to die than do vines that are maturing. If weather conditions are cool and cloudy, vines die slowly.

Vine killing usually must start two to three weeks before harvesting depending upon variety, conditions of growth, and time of year. Varieties that have large vines and are late maturing may require even more time.

Discoloration in the vascular ring of the tubers sometimes occurs after chemical vine killing. This discoloration has also been observed when vines were killed by heavy frost and on rare occasions when the soil dried out rapidly. Usually the discoloration is confined to the stem end of the tuber. Sometimes, however, it extends the whole length of the tuber. With chemical vine killers, the problem is usually more severe when soil conditions are dry and weather hot at the time of application. Also, chemicals that kill quickly are more apt to give discoloration than when a slow kill is obtained. Removing vines by cutting, burning, or pulling seldom results in discoloration of the vascular tissue.

Vascular discoloration may be severe enough to reduce tuber grade, especially for fresh market. Tubers with a badly discolored vascular ring do not make good chips or french fries because the dark ring shows up in the finished product. This discoloration has no effect on seed quality but often causes concern since it resembles the vascular discoloration caused by verticillium or fusarium wilt.

To reduce the danger of severe vascular ring discoloration from vine killing, the following are suggested:

1. Avoid using a chemical vine killer during hot weather, particularly if the soil is dry.

2. If tops must be killed when soil is dry and weather is hot, reduce the rate of material used and use a chemical that tends to kill the vines more slowly.
3. Roto beat or shred the vines before applying top killer.
4. If irrigation is available, have soil moisture adequate at the time of vine killing.

The three general methods used for vine killing are: 1) mechanical, 2) chemical, and 3) combinations of the two. Flail beaters and rotary choppers are popular mechanical methods. Machines should be adjusted to avoid disturbing the soil so that tubers will not be exposed to sunlight, frost, or mechanical damage.

Propane gas or oil flames are used in some areas to burn vines. However, recent regulations concerning the influence of smoke on environmental quality have reduced the use of this method. Vine burning has some disease control aspects that may be of significant benefit. Because conditions vary from area to area, local recommendations for kinds, rates, and timing of materials must be understood and followed.

Effectiveness of vine killing can be increased by practicing the following:

1. Roll or bend tops before spraying. This allows more spray to reach the plant stems and results in improved vine kill. Rolling the vines may also reduce the number of green (sunburned) tubers.
2. If a roto beater is used, have enough clearance between the flails and the top of the potato row to avoid uncovering and/or damaging tubers or disturbing the soil.
3. Do not apply vine killing chemicals during cool, damp, or extremely hot, dry weather.
4. Split applications of chemical vine killers may be more effective than a single application, under some conditions. Use one-half the suggested rate, followed by the second half 5 to 7 days later. Rolling before spraying may eliminate the necessity for the second application if weather is warm.
5. Use spray adjuvants that are recommended.

Harvesting Equipment

Most potatoes grown in North America are now harvested with mechanical harvesters (Fig. 20). Most harvesters are of the two-row type that harvest directly into bulk trucks that transport potatoes to packing sheds, processing plants, warehouses, or storages.

A few single-row harvesters are being used by small producers and a few growers are using potato diggers and picking potatoes by

Fig. 20. Potatoes are harvested primarily by 2-row harvesters which place the tubers into bulk-bodied trucks. The trucks are used to transport the potatoes to a central packing location, storage or processing plant.

hand into sacks, boxes, or barrels. Some manufacturers are offering three- and/or four-row machines; however, these are not widely used at this time.

In some areas, particularly where stones or clods are not a problem, windrowing is a common practice. With this method, two or four rows are harvested with a windrower and the tubers placed between two undug rows. Then the dug and undug rows are picked up with a conventional two-row harvester. This method increases the acres that can be harvested with one machine during a harvesting season, reduces machine traffic over the soil, and increases the volume of potatoes within the harvester.

Potato Bruising

It is difficult to determine all losses caused by bruising while potatoes are being harvested. Losses come from reduced potato prices, increased shrink in storage, increased processing costs, as well as the direct loss caused by bruising itself. Studies in some areas have shown that growers lose 20 percent of their income through potato injury at harvest. One study showed that 57 percent of all grade defects were due to bruising.

Types of Bruising

Blackspot and shatter bruises are the two major types of potato bruises. Blackspot appears as relatively uniform discolored areas beneath the skin and it is not visible until a potato is peeled. A blackspot bruise usually does not penetrate deeper than one-quarter inch and usually does not rupture the potato skin. Shatter bruises appear as a fissure or series of fissures, the flesh discoloring at the edges. Unlike blackspot, shatter bruises usually break the skin of the tuber and may penetrate deeply into the tuber.

Methods of Bruise Detection

Ways to detect bruising include 1) treatment with a chemical solution and 2) peeling. The most popular chemical detection material is catechol. The catechol treatment, applied to the outer surface of the potato, detects only bruises that break the surface of the potato. Since blackspots seldom break the skin, they are not detected by the catechol and tend to be overlooked.

Bruised potato tissue begins to discolor six to twelve hours after the injury occurs, often requiring 24 hours to reach a peak. The extent of the discoloration is not apparent until after the potatoes are peeled. A proper check of total bruise damage must include both shatter bruise and blackspot.

Since the method of bruise detection influences the amount of damage found, a grower should use the same method as the buyer of his potatoes. This is especially true where potatoes are sold on a contract that contains incentive and/or penalty clauses for a bruise level. The best method to determine total bruise damage is to peel the potatoes. The catechol bruise detection method is useful because bruised areas can be seen within a few minutes after treatment instead of waiting several hours for the bruised area to turn dark. The short delay for results makes the catechol method ideal for helping harvester operators analyze harvest performance and make operational and/or mechanical adjustments.

Factors That Influence Bruising

Four general factors determine the amount of bruise during harvest: 1) soil condition, 2) tuber condition, 3) temperature, and 4) harvester operation.

SOIL CONDITION. Soil condition at harvest determines the ease with which potatoes are separated from the soil. Heavy, compact, very wet soils are difficult to separate from tubers, while medium to light, loose, moist, soils separate easily. Proper soil moisture for harvest is between 60 and 80 percent of field capacity for loam and sandy soils. Heavy, dry soil forms clods which increase damage to tubers as they are carried through the harvester. The more difficult the separation, the more the harvester chains must shake, which in turn causes more damage to the tubers. In some areas stones in the soil increase the bruise problems.

TUBER CONDITION. The relationship between tuber condition and bruise susceptibility is not completely understood. But many cultural practices influence tuber condition, including fertility level, insect and disease control, irrigation, and timing of vine kill. Others undoubtedly are important but have not been studied in depth. Delaying harvest up to 20 days after vine kill increases the tubers' resistance to skinning and also appears to influence susceptibility to bruise damage.

Many aspects of "maturity" are still not understood. The cultural practices listed appear to influence the crispness of tubers (tuber hydration), which is an important factor in the type and amount of damage to tubers during harvesting.

Hydrated potatoes are susceptible to shatter bruise and resistant to blackspot. Dehydrated potatoes are resistant to shatter bruise and susceptible to blackspot. At a given temperature there is a tuber hydration level at which bruise damage (both blackspot and shatter bruise) is at a minimum.

TEMPERATURE. In general, the lower the temperature the greater the susceptibility to bruising. With each degree drop in temperature, bruising increases by about 0.5%. Thus, bruising would increase by 5% if the temperature should drop from 55°F to 45°F (12.8 - 7.3°C). Tubers are especially susceptible to bruising at temperatures below 50°F (10°C).

Temperature of potatoes in the field will be the same as the soil around them. As soil temperatures change the potato temperatures change also. Soil temperature lags behind air temperature. In one study, the lowest air temperature occurred about 6:00 AM but lowest soil temperature at tuber level was about 9:00 AM. The same relationship holds true for high temperature. Highest air temperature occurred at about 2:00 PM but highest soil temperature occurred at about 6:00 PM. Under these conditions a 12 hour harvest period for highest soil temperature would be from about 11:00 AM to 11:00 PM. This would help in bruise prevention when night temperatures drop below 50°F (10°C). In spring and summer harvest areas, where high temperatures are to be avoided, afternoon and evening harvest should be avoided.

HARVESTER OPERATION. Detailed suggestions on proper harvester operation are available from agricultural authorities in major potato producing areas. These suggestions should be followed because they are based upon local soil, climate, and other conditions. To harvest effectively with a minimum of bruising, harvester speed and adjustment are based upon local conditions.

Certain general recommendations to reduce bruising can be made, however.

1. Equipment should be in good repair. Equipment that continually breaks down makes for poor labor use. In addition, delays in harvesting cause growers to get anxious and hurry when they are operating, which may increase bruising. Speed can cause more breakdowns. Check over all equipment well in advance of harvest and replace broken or worn parts.

2. Potato harvest with little or no bruising is largely dependent upon the operator. Operating a harvester is not easy and requires a person who is conscientious and responsible. The operator must understand his role in reducing harvest damage. Volume of potatoes harvested per unit of time must be balanced against the quality of the job.

A person should be trained to operate the harvester according to local recommendations. Among other things he should be familiar with the following:

Digger Blade Depth–The digger blade should be deep enough to lift the maximum number of potatoes with a minimum of damage. Operating with the blade too deep will overload the aprons with soil and separation of tubers will be reduced. Operation of equipment with the blade too shallow results in cut potatoes and not enough soil on the apron to cushion the potatoes. New, automatic, hydraulic depth control devices are available to regulate blade depth.

Apron Pitch, Speed, and Agitation–Pitch is the length of each individual link from hinge point to hinge point. Pitches of 1.56 to 1.76 inches (3.96 to 4.47 cm) are available. The most common is a 1.56 inch (3.96 cm) pitch. In *wet conditions*, an apron of wider pitch with corresponding sprockets is recommended. Aprons with wide pitch are more suitable for the round varieties of potatoes than for the long or flat types. Avoid excessive agitation when the apron is without a heavy coating of soil for cushioning purposes. Thin the flow of material to improve separation. This can be done by reducing forward travel speed while maintaining a moderate apron speed. Avoid combinations of high apron speeds and high magnitude agitation, especially with bare chain links. Use rubber covered links. A 1.65 inch (4.19 cm) pitch apron worn to a 1.81 inch (4.60 cm) pitch not only has 18 percent more space between the links, but also travels at an increased speed. When a badly worn apron is replaced by a new one, the soil separation capacity may be reduced.

Travel Speed–The forward speed is determined by the digging conditions and varies accordingly. The key to the proper forward speed is to keep the quantity of soil lifted equal to the capacity of the aprons. All aprons should be operated so that the volume of material on them is equal to the capacity of that apron. Sometimes a change in sprockets is required to equalize the volume of soil and potatoes to the capacity of the chains throughout the entire length of a machine.

Reduce "Spill-Out" Losses–Spill-out losses occurring at the digger blade are variable and difficult to measure. Some corrective measures include running the blade deeper or cleaning and polishing the blade. If root materials are not cut and cause spill-out, sharpening the blades may be helpful. Use of dished coulters either on the harvester or as a separate operation to cut the vines and narrow the hill is practiced by some producers.

Control "Undersweep" and "Boiling"–"Undersweep" is the term used to describe the action of the soil which is sifted through the front of the harvester apron and dragged forward by the lower side of the apron. When excessive undersweep becomes troublesome it is often referred to as "boiling." Boiling can be reduced by taking slack out of the apron. Relocation of the idlers may help. Digging deeper and changing the tilt of the blade in combination with relocation of the front idlers may be helpful.

Use Padding–Use padding wherever potato bruising might occur. Use rubber covered apron links and reduce drops wherever possible to six inches (15.2 cm) or less. Padding should be placed in areas of the truck where loading begins — such as on the sides and bottom. Build the load to full height in these padded areas first, then continue loading on previously built mounds to reduce the distance the potatoes fall.

At the Storage

CAREFUL STORAGE LOADER OPERATION can reduce excessive bruising. Drops and roll-down lead to skinning and bruising that are seldom noticed until potatoes are removed from storage. The receiving hopper should be adjustable to keep the drop of potatoes from the truck or transport vehicle at a minimum. It should be large enough to prevent spill-out. The hopper edges and surfaces should be well padded to prevent nicks in the potatoes. Rubberize all chain conveyors. Belt conveyors should be cleated.

THE BOOM should swing in a wide arc and be easily adjusted to keep the drop from the boom to the piles to a minimum.

USE STRAW-FILLED BAGS on baffle boards. This will help reduce rolling and tumbling and hold floor crushing to a minimum.

A RUBBERIZED MAT may be placed on the floor and rear wall when starting to fill a new storage area. Once a few hundredweight of potatoes are on the pile, the mat may be pulled out.

A MAT BENEATH THE HOPPER will help prevent bruising from spillage during the unloading operation.

STORAGE

In the northern production areas a large percentage of the potato crop is stored for processing and fresh market through the winter and spring months. Many of the older storages were of the dugout type, partially below ground without any ventilation or humidity and temperature control. Many modern potato storages are entirely above ground, of concrete or corrugated metal exterior, insulated and equipped with a system for temperature, humidity, and atmospheric control (Fig. 21 & 22). Sizes range from 500 ton to over 20,000 ton capacity. In some production areas, the trend is away from small storages located on individual farms. With the expansion of the processing industry, particularly in the northwestern U.S., many of the larger storages are clustered near processing plants where better control of storage conditions can be maintained and season long accessibility to this stored crop is assured. With the increased consumption of processed potatoes and a resultant decrease in fresh market sales, storage conditions have become more critical. Mechanization in handling, both placement into and removal of potatoes from storage, has necessitated larger structures without obstructions such as upright supports within the storage area.

The design of storage structures varies considerably, primarily in methods of air distribution. Large air plenums are located on either or both sides, or in the middle with ducts running across or lengthwise, depending on shape and size of the storage. A common type of duct is galvanized corrugated pipe located above ground, although air ducts can be located below ground. Dirt floors are the most popular although many storages have concrete floors with wood-covered flumes in the center. The wooden covers can be removed as potatoes are flumed out. Moisture proof barriers with insulation are required on the walls and ceilings, the thickness of the insulation varying with storage location. In most of the northern production areas above the 43rd parallel and in other areas of high elevation, a minimum of 2" (5.08 cm) of urethane or its insulating equivalent on walls and 3½" (8.89 cm) or its equivalent on the ceilings is required. Because high humidity is required for potatoes in storage, condensation of water on the ceiling sometimes occurs. Proper design, adequate insulation, and air flow directed across the ceiling keep this problem to a minimum. Also the placement of heat cables along the eaves on the inside of the storage can reduce, if not eliminate, these problems. Requirements for storage in a specific geographic area should be obtained from the agricultural resource people in that area.

Physiological and Biochemical Changes in Storage

The objective of the storage environment is to keep the deterioration of the external and internal quality of potato tubers to a minimum. The quality of potatoes coming out of storage will not be any better than the quality of the potatoes placed into storage. Storage ability of potatoes is influenced considerably by production and harvesting practices. The maintenance of potato quality in storage is enhanced by care in growing, harvesting, and placement of tubers into storage.

The storage period can be divided into three periods. The first is the curing period or the period of suberization and maturation. The second, more lengthy phase, is the holding period, and the third is the warming period before removal. During the curing period,

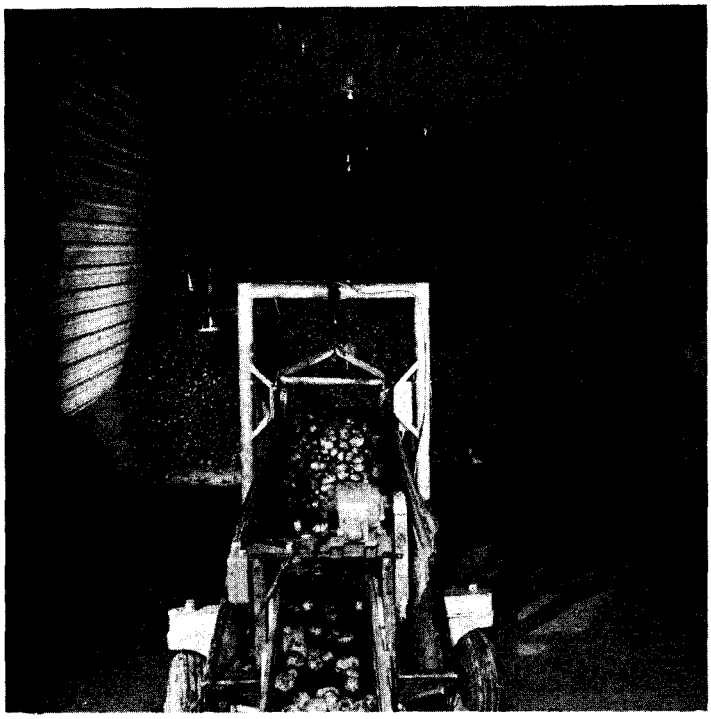

Fig. 21. Modern bulk storage bin being filled in the fall.

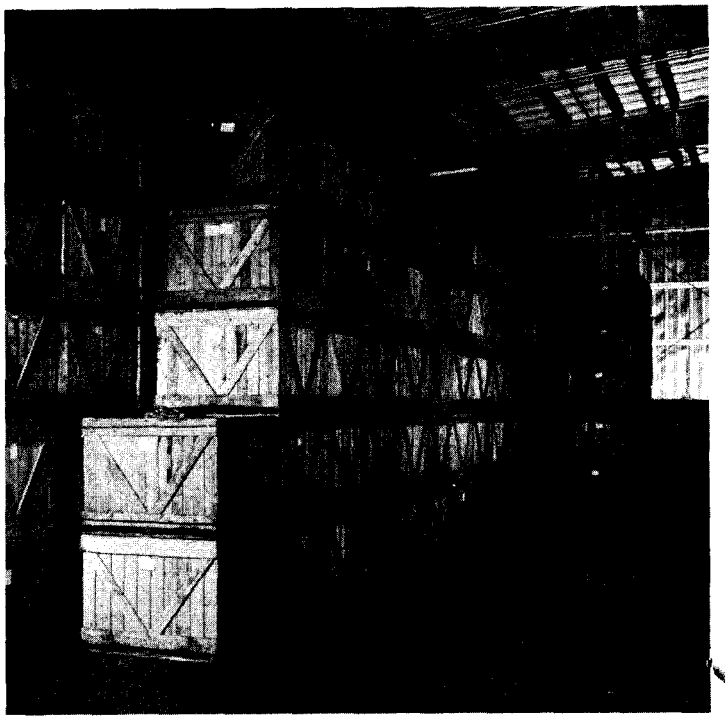

Fig. 22. Pallet box storage is an effective way to identify different lots of potatoes in processor and dealer storages.

bruises incurred during the harvest operation are suberized to prevent entry of rot organisms and immature tubers are allowed to mature (set and thicken the periderm). Temperatures of 50° to 60°F (10 - 15.6°C) are used, depending upon eventual use of the tubers, variety, relative maturity, and conditions of growth. Curing temperatures of approximately 50°F (10°C) are used when most of the potatoes are processed into frozen french fries, made into dehydrated products, or sold on the fresh market. Where potatoes are processed into chips, higher curing and holding temperatures are used because of differences in varieties and a lower maximum allowance of reducing sugars. Length of the curing period varies considerably from 2 weeks to several months. Relative humidity above 95 percent is a necessity for the suberization process and to keep weight loss to a minimum.

Proper curing of tubers is necessary to ensure storage without loss of quality. In relatively warm fall areas a considerable amount of field heat as well as heat of respiration must be dissipated, requiring forced ventilation with cool night air. Removing heat is necessary to keep rot to a minimum and to keep tubers from physiologically aging, which eventually results in greater development of reducing sugar and premature sprouting. If tubers are relatively immature, they should be kept at curing temperatures for longer periods to ensure maturation of the skin for minimum weight loss.

Tubers are kept at holding temperatures of between 40 and 50°F (4.4 - 10°C) depending on ultimate use. Chip potatoes are generally stored at a minimum of 50°F (10°C) while those used for making french fries are kept at 45°F (7.3°C) and fresh market and seed potatoes are maintained near 40°F (4.4°C). The accumulation of reducing sugars and deterioration of texture preclude storage of processing potatoes at low temperatures. Constant storage temperatures are more desirable than fluctuating temperatures. High relative humidity is desirable to keep weight loss to a minimum and to prevent the occurrence of pressure bruises.

When potatoes have been kept at low holding temperatures, they should be warmed to approximately 50°F (10°C), before removal from storage to reduce bruising. When excessive reducing sugars have accumulated in storage, the amount of sugar can be reduced by holding the tubers at higher temperatures for 3 weeks or longer.

Most varieties of potatoes are in the resting stage for two to three months after harvest. To prevent sprout development in potatoes stored longer than this, chemical sprout inhibitors are used. The two most common inhibitors are maleic hydrazide (MH) and chlorpropham (CIPC). MH is applied to the green foliage in the field two to three weeks after full bloom stage. The inhibitor is translocated to the tubers and will keep potatoes sprout-free through the storage season. CIPC is applied through the ventilation system in a vapor form after the period of suberization and maturation, usually in December.

Ventilation and Humidification

The primary purpose of ventilating potato storages is to remove field heat and heat of respiration. Forced movement of air through potatoes also maintains uniform temperature and humidity throughout the pile. A good ventilation system can also be used to control progress of wet rots by drying out areas of the pile which look wet as well as drying tubers which are harvested in a wet condition. Excessive accumulation of carbon dioxide especially during the high respiration period early in the storage period can be prevented by adequate ventilation.

Air distribution through potato piles is attained by various methods according to areas of production. Air ducts are spaced from eight to ten feet apart beneath the pile. These ducts are made of various materials. Corrugated steel or aluminum pipes of different sizes according to size of storage with outlet holes spaced from 8 to 12 inches (20 - 31 cm) apart are used in some areas. In other areas, wooden A-frame slotted air ducts are used. The air is distributed to lateral ducts by a main plenum connected to the fan house. Variations of this basic distribution system exist in the various producing areas.

The capacity of ventilation systems varies depending on the availability of low night temperatures for cooling. The variation in capacity is from 0.5 cfm/cwt to 2.4cfm/cwt. Higher air capacities are sometimes used to control soft rot and for drying tubers which were harvested wet. After the initial cooling period, high air velocities are not generally required.

In arid climates the addition of moisture to air used for cooling is a necessity, particularly during the initial cooling period. Evaporation of moisture in the air has the additional benefit of increasing cooling capacity. Many storages have small centrifugal type humidifiers which distribute a fine mist into the air stream. Generally this type of humidifier is inadequate when large amounts of cool air are brought in during the cooling period. Large air washers, whether commercial types or built-in are becoming more popular and provide more adequate humidification. Refrigerated water chiller units can give additional cooling capacity to air washers if necessary. Direct expansion refrigerated storages are used to keep potatoes for prolonged periods into the early summer months.

BREEDING IMPROVED POTATO VARIETIES

Certified seed of 68 named varieties was grown in 1975-76 in the United States and Canada, and six varieties — Russet Burbank, Katahdin, Sebago, Kennebec, Superior, and Norchip — accounted for just over 80 percent of the acreage. Russet Burbank (Netted Gem) was the only variety of the six not developed through a federal, state, or private breeding program and all except Superior and Norchip were introduced prior to 1949. Although breeders have developed many new varieties over the years, it has been very difficult to replace older established varieties. If one considers the very complex genetics of the potato together with the varied demands of the consumer, the grower, the processor, and the shipper-handler, the task facing the potato breeder is monumental.

Fig. 23. Gathering potato pollen on thumbnail is one of the steps in making crosses.

Photo: USDA

The first and most important step in a breeding program is the choice of parents, which are chosen because of certain desirable characters, i.e., good yield, smooth tubers, wide adaptability, resistance to one or more diseases, etc. Crosses are made between two parents with the hope that some of the resulting progeny will have most of the desirable characters of the two parents.

Crosses usually are made in the greenhouse in the spring when conditions are favorable for flowering and fruit set — good light intensity, adequate day length, and relatively cool temperatures. Crosses also can be made during the summer in the field, in air conditioned greenhouses, in screenhouses, or at any time in controlled environment rooms. Many breeders use the cut-stem technique to make crosses which otherwise would be difficult or because of convenience. Flower bearing stems from field plots of the female parent are collected, placed in water, and the flowers pollinated with pollen gathered from the male parent (Fig. 23).

The large potato flower, similar to that of its relative, the tomato, contains both male and female parts and is easy to manipulate during crossing. Not all varieties can be used as male parents because of (sterile) nonfunctional pollen. If a variety is to be used as the female, the anthers — pollen bearing male parts — are removed with forceps before the flower opens (Fig. 24). Pollen from the flowers of the male parent is applied to the female part of the emasculated flower. The small greenish seedball similar to a very immature tomato fruit, ripens about eight weeks after fertilization and usually contains from 100-300 seeds (Fig. 25). Freshly harvested seed has a dormant period of several weeks and will not germinate immediately unless treated with giberellic acid.

The next step is the production of seedling tubers for growing in the field. Seed is sown in a sterilized medium in summer or fall, and the seedlings are transplanted to small pots in a greenhouse, coldframe, or hotbed. Small tubers are ready for harvest in about three to four months. The largest tuber from each plant is stored for planting the following spring. Additional tubers may be saved for exchange with other breeders or for cooperators in other areas to plant and select under local conditions. Several breeders use transplants for efficiency and economy. Seed is sown in late winter and seedlings are transplanted to the field like tomato transplants.

About 10,000 to 50,000 seedling tubers or transplants are planted in the field each year depending on the size of a breeding program. Some breeders screen populations at the seedling stage for such characters as disease resistance, since large numbers can be handled and susceptible plants can be eliminated early.

Seedling tubers or transplants are planted by hand or by machine in rows at wide spacing to permit harvest of the individual hills with a small mechanical digger. Each seedling hill or clone is examined by one or more persons and is saved or discarded based on maturity, overall appearance of tubers and obvious defects. Most breeders save less than five percent of the seedling hills at this stage. Other breeders, feeling that it is too difficult to judge the potential of a clone at this stage, save a single tuber of a much higher percentage of the single hills and grow these in four hill plots the following year. It is relatively easy to maintain the genetic constitution of a selected clone for the potato is asexually propagated from tuber seedpieces. The biggest problems for the breeder are mixtures and the maintenance and increase of seed tubers free from virus and other diseases.

The program, after the first year of selection, is one of testing to identify valuable clones and to produce seed for more extensive trials. Selected clones are grown in multiple hill rows at normal spacing in the second and third years. In the third or fourth year selected clones are grown in replicated trials with commercial varieties or standards, and in replicated trials at several locations in subsequent years. During this period selections not only are evaluated for tuber and vine characters and yielding ability, but also may be tested for disease resistance, culinary and processing quality, or any other character the breeder deems important and can test efficiently. If possible, half-acre or larger semi-commercial trials are employed to evaluate fully a selection for yield, adaptability, and processing quality and to provide an opportunity for major defects to be exposed.

Usually after eight or nine years of testing, a clone which appears equal to a commercial standard variety for most important characters and superior for one or more is named, and a description of the new variety is published. Seed is released officially to certified seed growers and to researchers interested in conducting their own tests.

The future of potato breeding looks bright. Systematic collections of wild and cultivated tuber bearing species native to South and Central America and to Mexico have been and are continuing to be made. Research centers and introduction stations have been established in the United States, South America, and Europe to preserve and make this collected material available to research workers and to breeders who are expanding their use of this enormous reservoir of germplasm.

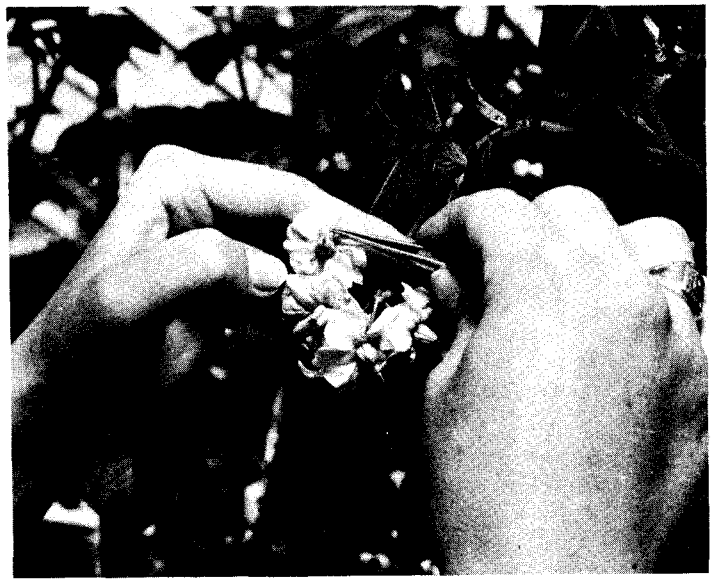

Fig. 24. Preparing a potato flower for crossing.

Photo: USDA

Fig. 25. Closeup of a cluster of potato fruits.

Photo: USDA