

OPTIMAL EQUIPMENT INVESTMENTS FOR NORTHERN PLAINS GRAIN FARMS

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CASE DESCRIPTION

This case presents a teaching tool which requires students to identify an optimal equipment plan for a northern plains small grain farm. Students are presented with information from a farm owner regarding farm size, available labor, farming techniques used and other relevant issues. Students are required to analyze this information to identify the equipment necessary to operate the farm. Students must balance equipment costs and labor issues. They must develop a plan that remains within a predetermined budget. Students use online resources to identify specific equipment along with their appropriate prices. Students are also invited to make general recommendations and comments. This case is suitable for an agricultural economics, agribusiness, or agronomy class. The case is appropriate for use at the senior, or masters level. In some instances, the case may be valuable for Ph.D. students. Students should have some familiarity with farm equipment and the equipment needs of small grain farms before being assigned the case. Students might be assigned to work individually or in teams on the project. Individuals or groups may be required to present their research to the class for discussion and comment. Completion of the case should require 5-10 hours outside of class. Classroom discussion should be about two hours.

JEL: Q12, Q14

KEYWORDS: Farm Finance, Farm Equipment, Capital Budgeting

CASE INFORMATION

David Cobbelston recently retired from farming and moved to the city near his farm. As with many retiring farmers, he managed his equipment to be near the end of its useful life at the time he retired. He recently held a farm auction to sell the machinery from his operations. However, he is planning to retain ownership of the 4,000 acres of land and rent it to other farmers. Today, he approached his son John to inquire about his interest in renting the land. John has wanted to operate the family farm since he was a young child and is excited by the prospect. He would like to quit his job as an account executive for Pitney Bowes to take over the farming operation. As the spring planting season is approaching, David has given John only two weeks to make a commitment.

John needs to investigate financing, potential profitability, his family's willingness to relocate and many other issues to make an informed decision. While John is familiar with farming operations there are certain economic elements he will not have time to fully explore in the two weeks before he must make a decision. One concern is how much money he will need to spend on machinery. He knows his budget will be limited because of funding availability. He has approached you, Bill, an agribusiness major at the local university to assist him. He has asked you to develop a machinery plan for the farm. You are glad to undertake the project, as you think you will learn something, and the consulting fee will pay for your spring break trip. You have taken many classes on agribusiness, finance and other management issues and grew up on a grain farm, so you feel well qualified to handle the task.

You realize that in order to develop the machinery plan, you will need some additional information about the farming operations. You schedule a meeting with John for 8:00 the following morning to gather information. At the meeting, John and David begin by telling you the farm has 4,000 tillable acres. The land is mostly located within a seven mile radius of the farm headquarters with 1,280 acres located ten miles from the headquarters.

The farm has been used exclusively for small grain production. Recently, David had been growing spring wheat, durum, feed barley and safflower. The advantage of this combination is the crops require the same equipment and have somewhat different seasons. This spreads the work out over a longer period of time and allows for more efficient equipment use. Moreover, this combination provides an element of diversification from crop disasters and crop price variations. The land is capable of growing a number of other crops including flax, rye, oats, triticale, winter wheat, sunflower, canola, millet, crambe and spelt. Malting barley is occasionally grown in the area.

In recent years, David has grown about 480 acres each of feed barley and safflower. He has grown about 640 acres of durum and the remaining land has been planted to spring wheat. Crops are typically rotated to different fields in subsequent years to reduce weed and disease problems. John plans to continue growing the same crops in about the same quantities. The land is continuously cropped, so every acre of land is planted every year. The most common method of farming in the area is no-till and John wishes to utilize this approach.

The farm is located 17 miles from a small farming community, Nickinson, with a population of 600 people. It is about 45 miles from a regional center, Avelock, with a population of 25,000 people. A good supply of parts for John Deere and Case IH equipment is available in Nickinson, and parts for most other makes of equipment are available in Avelock. Grain markets where the farm's production is sold are located about 25 miles from the farm.

The farm headquarters has a house and large workshop. There are also two steel buildings that can be used for grain storage or machinery storage. The farm has 200,000 bushel of grain storage all located at the farm headquarters. The grain storage is connected by a series of electric powered elevators, that were not sold at the farm auction. In addition, the equipment for a 3,500 bushel, bin drying system remains in place. A 500 bushel grain pit allows for fast unloading of trucks. All other farm equipment, including the shop equipment, was sold at the auction. John tells you a large capacity 66 foot or longer auger will be required for loading grain into the bins. A 40 foot unloading auger and bin sweep are required to remove grain from the bins and steel buildings. Electricity is available at the bin site.

John and his wife Kathy plan to work the farm together. While Kathy is interested in living and working on the farm, she is not interested in the business of farming. John has agreed to manage the business elements of the farm. Both are willing and able equipment operators. In addition, they have a son, Joe, who is 16 years old. Joe helped his grandfather on the farm the past two summers and is capable of operating most farm machinery. He is excited about the prospect of helping his father. David indicated he would be willing to help John during peak planting and harvesting seasons. Outside labor is available in the area but is expensive during peak planting and harvesting seasons. John tells you that he would like to have enough equipment so that seeding and harvesting can each be completed in about 25 working days. He wishes to operate the farm without hiring outside labor. John and Kathy are both handy in the repair shop. They are capable of handling small to medium sized repairs, including welding and so forth. Neither are capable of handling highly technical projects such as engine overhauls.

John and David describe the production element of the farming process as follows. The production year begins about March 1. The first step is to acquire the necessary planting supplies and move them to the farm. This is generally done with grain trucks and takes about one week. Supplies include seed, dry

fertilizer, fuel, and various chemicals. The farm has ample space to store all the supplies needed during the planting process with the exception of fuel. The fuel tanks were sold at the farm auction.

After the supplies have been purchased, seeding begins. The seeding process starts by spreading bulk fertilizer on the fields. Normally, dry fertilizer is spread in a fertilizer spreader. Fertilizer spreaders are pulled with a smaller tractor, having perhaps 70-100 horsepower. Some seeding equipment has the ability to combine fertilizer application with the seeding process. In these cases, the spreading application is not required. Depending on the amount of weeds that start in the spring, a pre-plant spraying to burn down weeds may be necessary.

Seeding begins as early as mid March and can extend into June, depending upon weather conditions. Generally, crops which are planted earlier produce higher yields. Seeding starts by trucking seed and fertilizer to the seeder. The seed and fertilizer are transferred from the truck to the seeder. The seeder proceeds to plant the field. Seeders operate at about 5.5 to 6 miles per hour. It takes 80-100 tractor horsepower for each 10 feet of seeder used. The operator must spend a certain amount of time adjusting settings on the seeder for optimal planting, refilling the seeder, and moving the seeder from field to field. A seeder can be operated a maximum of about 10-12 hours per day. Barley is usually seeded first, followed by wheat and durum. Safflower is seeded last.

Wheat, barley and durum are susceptible to broadleaf and grassy weeds. Spraying for broadleaf weeds occurs about two to three weeks after the grain has emerged from the ground. Spraying must optimally be completed in a two to three week window. Sprayers typically operate at about 10-15 miles per hour. Pull type, self propelled or pickup mounted sprayers would be suitable for the task. The amount of time that sprayers can be utilized is limited on any given day because of wind and other weather conditions. Wind can cause chemicals to drift to nearby fields resulting in undesirable damage. On average spraying can occur for 3-4 hours per day. A second spraying is sometimes necessary in the same time period to control wild oats. A pre harvest burn down occasionally necessary. Spraying requires the application of about 3-6 gallons of water per acre in addition to the chemicals. Sprayers range in size from 300-1,200 gallons. Returning to the farm headquarters requires about 1.5 hours to refill the tank. Refilling can be completed much faster with a nurse tank that makes water available immediately at the field.

Barley harvest begins in late July or early August. Wheat and durum harvest immediately follow. While wheat and durum are harvested about the same time, they must be handled and stored separately. Safflower is usually harvested in October. The grain is straight harvested so windrowing equipment is not necessary.

Combines can operate about 8-10 hours per day. Modern era combines operate at 6-8 miles per hour. As the combine harvests, the resulting grain is transferred to trucks for transportation to the grain storage facility. Barley will ordinarily yield about 70-100 bushel per acre, spring wheat and durum between 30 and 60 bushel per acre. Safflower commonly yields 1,000-1,500 pounds per acre. A single axle truck will hold about 300 bushel of wheat, a tandem axle truck, 550 bushel, and a semi with trailer about 1,000 bushel. Safflower and other crops produce similar volumes. It takes on average 15 minutes for the trucks to get from the fields to the storage facility, with the trip from the most distant field being about 30 minutes. Return trips take about the same amount of time. Unloading at the storage facility takes an additional 10-15 minutes with a ten inch auger.

In the weeks following harvest, it is sometimes necessary to spray the land to kill any late emerging weeds. It is also necessary to mow road ditches bordering the land to minimize snow drift problems. This usually occurs in October after the first hard frost.

Grain can remain in the storage facility for several years without problems. However, more commonly grain is removed from the storage facility and sold in the local market sometime between October and February. Other activities during the winter months include repairing and refurbishing farm machinery, taking a vacation, tax planning, general planning and government program planning for the following year. This completes the crop cycle.

John tells you he has limited funds available to purchase machinery. He hopes to accumulate enough machinery to operate the farm with \$110,000. He is well aware this implies the equipment will be older model used pieces. He could potentially raise some additional capital for machinery purchases if necessary. He has asked you to prepare a plan with several different funding levels to help make his decision. Specifically he would like recommendations for each a \$110,000, \$220,000, \$330,000 budget. In addition, he would like a budget that includes late model versions of major equipment pieces. Finally, he would like a budget that includes only new equipment.

With this information you are tasked with developing a machinery plan for the farm. You consult your agribusiness professor who suggests you conduct research on machinery needs and prices using online resources. He recommends you consider information from the following websites to develop your plan: www.tractorhouse.com, www.machinerytrader.com, www.fastline.com, www.agdealer.com, www.ironsearch.com, www.machinerypete.com, www.grainfarmer.com, www.usedfarmequipment.com, www.equipmentlocator.com and www.truckpaper.com.

QUESTIONS

1. Determine the size and amount of machinery needed to operate this farm. Using internet resources, identify specific pieces of machinery that meet the needs of the farm and collectively remain within the \$110,000 equipment budget. Please print pictures and include them with your completed case study to show the recommended equipment.
2. Do you have any cautionary notes for John regarding this plan?
3. If another \$20,000 of budget becomes available, which piece(s) of equipment should be upgraded, or which additional piece of machinery should be purchased.
4. Now suppose John indicates that Joe is not likely to be available to work in the summers because he wants to spend time in Hawaii learning to surf. Thus seeding and harvesting will need to be completed without his assistance. Nevertheless, John wishes to avoid hiring outside helpers. How does this change the machinery plan? You do not need to completely redesign your machinery plan, but should identify areas where change is necessary.
5. Now suppose David suggests he may move permanently to Europe. If he did, he would not be available to help as originally indicated. If neither Joe or David are available to help during peak seasons, what adjustments need to be made? Again assume no outside labor is hired. You do not need to completely redesign your machinery plan, but should identify areas where change is necessary.
6. Return to the original farming plan, excluding the additional land suggested in question six and with both Joe and David available to work. John has been contemplating the addition of corn and sunflower production into the mix of crops grown on the farm. A retired neighbor has asked if he would like to rent 640 acres of his land for that purpose. The neighbor suggests the possibility of about 320 acres of each corn and sunflowers. John is aware that this would require him to acquire row crop farming equipment. An advantage of growing sunflowers and corn is

that these crops follow a slightly different season and would not interfere with other work. How much would it cost for John to add the necessary equipment for this purpose? Please provide pictures of the recommended equipment.

7. Return to the original farming plan, excluding the additional land suggested in question six and with both Joe and David available to work. Suppose John discovers that his investments have performed much better than he was aware. Instead of having \$110,000 to spend on machinery, he has \$220,000 to spend on machinery. Develop a new machinery plan taking this new information into account. Please provide pictures of the recommended equipment.
8. Continuing with the original farming plan, how would you change the machinery plan if \$330,000 were available to purchase machinery. Please provide pictures of the recommended equipment.
9. Based on the original farming plan, consider a situation where the major pieces of equipment are must be less than six years old. Develop a machinery plan that includes these modern equipment purchases. Please provide pictures of the recommended equipment.
10. Finally, based on the original farming situation, develop a machinery plan that involves the purchase of all new equipment. Please provide pictures of the recommended equipment.
11. Given your computations above, how much money do you recommend that John spends on Machinery, \$110,000, \$220,000, or \$330,000, or some other amount.
12. Do you have any final comments or suggestions for John?

OPTIMAL EQUIPMENT PLANNING FOR NORTHERN PLAINS GRAIN FARMS

TEACHING NOTES

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CASE DESCRIPTION

This case presents a teaching tool which requires students to identify an optimal equipment plan for a northern plains small grain farm. Students are presented with information from a farm owner regarding farm size, available labor, farming techniques used and other relevant issues. Students are required to analyze this information to identify the equipment necessary to operate the farm. Students must balance equipment costs and labor issues. They must develop a plan that remains within a predetermined budget. Students use online resources to identify specific equipment along with their appropriate prices. Students are also invited to make general recommendations and comments. This case is suitable for an agricultural economics, agribusiness, or agronomy class. The case is appropriate for use at the senior, or masters level. In some instances, the case may be valuable for Ph.D. students. Students should have some familiarity with farm equipment and the equipment needs of small grain farms before being assigned the case. Students might be assigned to work individually or in teams on the project. Individuals or groups may be required to present their research to the class for discussion and comment. Completion of the case should require 5-10 hours outside of class. Classroom discussion should be about two hours.

GENERAL COMMENTS

This case represents a considerable challenge for students. It requires them to properly equip an entire farm. Moreover, students are faced with a very constrained budget. In the first analysis, students are limited to spending \$110,000. A single new combine can cost in excess of \$300,000. Thus equipping an entire farm with the many different pieces of equipment required for \$110,000 is difficult at best. Nevertheless, this is the type of challenge faced by many new and established farmers. Clearly, in the constrained budget analyses, the farm will need to be equipped with older model equipment. As the farm is of considerable size, students should be looking at purchases of large equipment. Students are also required to develop machinery plans for other budget amounts. While students should provide pictures with their case solution, pictures are not included here to conserve space.

The following provides a sample machinery plan. The case is open ended, so student solutions may differ markedly from what is presented here. The plan developed here is based on machinery and pricing available in May 2010. Prices reported are based on advertised prices without consideration of any negotiated discounts or transportation charges. Professors who wish to develop a shorter assignment might require students to complete a plan for a single budget amount rather than for several candidate budgets.

QUESTIONS

Question 1: Determine the size and amount of machinery needed to operate this farm. Using internet resources, identify specific pieces of machinery that meet the needs of the farm and collectively remain within the \$110,000 equipment budget. Please print pictures and include them with your completed case study to show the recommended equipment.

Solution 1: Several calculations are needed to determine the size of equipment needed to operate this farm. As the owner has indicated a limited equipment budget, it may be necessary to select some pieces of equipment that are on the smaller side of what is necessary. Each major equipment item is addressed in turn.

John has indicated he would like have the capacity to complete the seeding operation in about 25 days. Seeders operate at 5.5 to 6 miles per hour and typically operate 10-12 hours per day. Common large capacity seeding equipment are 30, 45 and 60 foot widths. The first step is to determine how many acres each of these machines can complete in one day. One acre of land is 43,560 square feet. This translates into an area 8.25 feet wide by one mile long. Thus, when traveling one mile, a 30 foot seeder will cover $30/8.25 = 3.636$ acres. Traveling at a speed of 5.5 miles per hour, the machine can cover $3.636 \times 5.5 = 20.00$ acres per hour. Thus, in a ten hour day, the machine is capable of covering 200 acres. A certain amount of time must be allocated for setting, refilling and moving the machine. This equals approximately 25 percent of the machine's potential. Thus the machine will cover about $200 \times 0.75 = 150$ acres per day. Over a period of 25 days, the machine will cover 3,750 acres. Using similar calculations, a 45 foot machine would cover about 5,625 acres and a 60 foot machine 7,500 acres. While the 30 foot seeder is slightly smaller than John has requested, it more closely meets his needs than a 45 foot seeder. The specific recommendation is for a 1989, Case IH, model 8500. The cost of these machines is about \$9,500. The Case IH, model 8500 seeder cannot deep place large amounts of nitrogen fertilizer. Because of this limitation, you will also need a fertilizer spreader to distribute nitrogen prior to seeding. You recommend a Willmar S200 spreader for 2,600.

The size of the primary tractor required depends on the size of the seeder purchased. In order to pull a 30 foot seeder, a tractor with 240 to 300 horsepower is required. By selecting a tractor that has closer to 300 horsepower, higher speeds can be achieved thereby overcoming some lack of seeder size. The recommendation is for a 1979 International 4586. These tractors are quality machines with 300 horsepower that can be purchased for a low price. The recommended machine costs \$10,000.

An 80-100 horsepower tractor is needed for utility operations, such as moving snow and dirt, lifting objects, spreading fertilizer and operating pull type sprayers and power take off (PTO) driven grain augers. The tractor should have a loader, 3 point hitch and power take off. The recommendation is for a 1978 White, 2-135 tractor with loader, 3 point hitch and PTO available for \$8,000. While this is more power than needed for utility operations, it has several valuable added capabilities, including the ability to handle sizeable row crop equipment should John elect to grow those crops in the future.

Spraying equipment is a particularly important piece of machinery because the window for completing spraying operations is narrow and can be disrupted by a variety of weather conditions. Sprayers come in widths from 40 to 120 foot. They typically operate at about 10-15 miles per but are only able to work about 3-4 hours per day. To determine the amount of machinery needed, you note that different crops need to be sprayed at different times. The primary limitation is spraying barley, spring wheat and durum. These crops represent the bulk of the farming operations, and spraying would occur at about the same time for each. These crops are planted on 3,520 acres.

An 120 foot sprayer could cover about $120/8.25 \times 10\text{mph} = 141$ acres per hour. In a four hour period the sprayer could cover about 564 acres. Refill and move time can be substantial depending upon the water source location. Commonly a nurse tank is used to facilitate rapid refilling. Including refill and move time, coverage for a 120 foot sprayer is estimated to average 100 acres per hour, or 400 acres per average day. Given the sensitivity of spraying to time of application and weather conditions and the fact that additional spraying equipment is relatively inexpensive, a 50 foot pickup sprayer is recommended to supplement the 120 foot sprayer. This smaller sprayer will be more nimble and able to negotiate smaller

areas and spaces with tight turns. The second sprayer will allow coverage of an additional 200 acres per day. Used pickup sprayers are available in many makes and models for about \$3,500. The recommended pull-type sprayer is a 1994, 110 foot Summers SuperSprayer costing \$4,500. In addition, a 2000 gallon home manufactured nurse tank is recommended at a cost of \$2,000.

Due to the no-till nature of the farming operation, tillage equipment will have limited value. Nevertheless, a disk would be beneficial for preparing troublesome weedy spots. An older version International Model 490, 28 foot disk will be sufficient for any tillage required. These disks are available for about \$3,000.

Harvest represents a major step in farming operations. Harvest requires several pieces of machinery and is the most labor intensive part of the production process. Combines are the heart of the harvest operation and represent a significant investment. Given John's financial limitations, older equipment will need to be purchased. Nevertheless, given the substantial size of the farm, the equipment needs to be large. Two 24 foot machines from the mid 1980's would meet the requirement. Combined these machines should cover about 200 acres per day, thereby falling within the 25 day harvest window. Two 1983 Gleaner, N-7 Combines that are in good condition for their age and include 30 foot headers are recommended at a cost of \$14,000 each. The added capacity of the 30 foot headers over the 24 foot headers will increase the harvest speed by about 25 acres per day per machine.

Trucks are needed to transport grain from fields to the storage facility during harvest and again from the storage facility to grain markets after harvest. Trucks are also used to transport seed and fertilizer to the seeder. As the trucks will drive relatively few miles each year older tandem axle, lift-tag trucks should be suitable for the task. Specifically, the recommendation is for three 1973, C70, gasoline powered, Chevrolet trucks each costing \$6,500. Having two 30 foot combines and three 550 bushel trucks may present some limitations, particularly when working on fields further from the headquarters. The combines may have to stop working from time to time because of tucking capacity. Two grain augers, one for loading into bins and the other for loading out of bins are required. For loading into bins, the recommendation is a ten inch diameter, 66 foot in length, Feterl auger with an electric motor available for \$3,000. For loading out of the bins, the recommendation is for an eight inch diameter, 40 foot in length, Westfield grain auger with an electric motor that costs 2,500. A used Wheathart bin sweep should be purchased for about \$500.

A service pickup is needed to transport fuel to the field, and carry a supply of repair tools. The recommendation is for a 1989, Ford F-250 costing \$2,500. In order to mow ditches, a mower or windrower is necessary. The recommendation is for a 1975, Versatile 400, self propelled, windrower. Nice versions of this older machine are available for about \$2,500.

Some shop equipment is required. The recommendation is to spend extra money on shop equipment because of the equipment's age. The recommendation is for a \$500 wire welder, 500 cutting torch, and \$500 air compressor. Various other tools and shop equipment costing an additional \$2,000 will be required. It is necessary to have fuel storage tanks on the farm to meet daily fuel needs. Two used 500 gallon tanks costing \$500 each should be suitable. Finally, \$2,000 of expenditures on miscellaneous items should be anticipated.

The recommended equipment purchases are presented in Table 1. The total cost of the equipment selected is \$108,100, which is within the \$110,000 limit.

Table 1: Recommended Equipment Purchases for a 4,000 Acre Grain Farm \$110,000 Budget

ITEM	COST
1979 International 4586 Tractor	\$10,000
1989 Case IH8500, 30 foot seeder	\$9,500
1978 White 2-135 tractor w/ loader, 3pt and PTO	\$8,000
Willmar S200 Fertilizer Spreader	\$2,600
2,000 Gallon Water Nurse Tank on Trailer	\$2,000
Pickup Sprayer 50', 500 Gallon	\$3,500
Summers 120' 1,000 Gallon Pull Type Sprayer	\$4,500
International 490 Disk 28'	\$3,000
Versatile 400, Self Propelled Windrower	\$2,500
2, 1983 Gleaner N-7 Combine w header	\$28,000
3, 1973, C-70 Chevrolet Tandem Axle Trucks	\$19,500
Large Capacity Grain Auger	\$3,000
Grain Auger and Sweep	\$3,000
Service Pickup	\$2,500
Shop Equipment	\$3,500
Fuel Storage Tanks	\$1,000
MSC	\$2,000
TOTAL	\$108,100

This table shows recommended machinery purchases for a Northern Plains grain farm of 4,000 acres. The recommendation is limited to a budget of approximately \$110,000.

Question 2: Do you have any cautionary notes for John regarding this plan?

Solution 2: The most notable issue in this plan is the equipment age. The equipment recommended is mostly about thirty years old. This presents certain issues with break downs and parts availability. These issues could impact the amount of work that can be accomplished and long term cost of the equipment. John should be aware of this and should spend time during each winter working on equipment. Specifically, each piece of equipment should be carefully evaluated in terms of its ability to adequately work another season. If the machines are capable of working another season, the equipment should be carefully maintained and repaired during the winter months, so it is fully prepared for the growing season. If the equipment is not suitable for another season, it should be traded for better equipment. Further, John should set aside an amount of money for machinery replacement in the event a break down occurs that is not economically feasible to repair. For example, if the engine in the International 4586 were to fail, repair would not be sensible. Rather, it would be advisable to replace the equipment. Being financially prepared for this eventuality is vital.

Question 3: If another \$20,000 of budget becomes available, which piece(s) of equipment should be upgraded, or which additional piece of machinery should be purchased.

Solution 3: There are several candidate upgrades. Perhaps the first would be to purchase a larger tractor. Adding \$15,000 to the tractor purchase price would allow John to acquire a tractor in the 400 horsepower range. Candidate tractors include an International 4786 and John Deere 8850. With the extra power, John could pull a 45' seeder rather than a 30' seeder. Older model 30' and 45' seeders are priced approximately the same. So the larger seeder does not imply additional cost. Thus an additional expenditure of \$15,000 would increase seeding capacity considerably. It may also be advisable to increase trucking capacity. There are two primary ways this could be done: purchasing additional or larger trucks or purchasing a grain cart. Given only \$5,000 of available funds after the tractor purchase, it may be best to replace one truck with a semi and trailer.

Question 4: Now suppose John indicates that Joe is not likely to be available to work in the summers because he wants to spend time in Hawaii learning to surf. Thus seeding and harvesting will need to be completed without his assistance. Nevertheless, John wishes to avoid hiring outside helpers. How does

this change the machinery plan? You do not need to completely redesign your machinery plan, but should identify areas where change is necessary.

Solution 4: The absence of Joe creates interesting challenges. Seeding and spraying should remain manageable without Joe. Harvest is more severely impacted. Without Joe, the harvest must be completed with only three people. This implies two combine operators and one truck operator. In this case, John should consider purchasing at least one larger truck. A Semi truck and trailer, while somewhat more expensive, would be an advisable investment. In addition, a larger unloading auger would be advisable. Changing the ten inch auger for a 12 or 13 inch auger would speed truck unloading considerably.

Question 5: Now suppose David suggests he may move permanently to Europe. If he did, he would not be available to help as originally indicated. If neither Joe or David are available to help during peak seasons, what adjustments need to be made? Again assume no outside labor is hired. You do not need to completely redesign your machinery plan, but should identify areas where change is necessary.

Solution 5: This change has a significant impact on the farming operations. It will still be possible to manage seeding and spraying with some careful planning. However, significant changes to the harvest operations will be necessary. Moreover, making these changes while remaining within a \$110,000 budget is a significant challenge. In this case, John should not purchase two combines. One newer combine with additional capacity should be purchased instead. A 1996 Gleaner R-72 combine for \$34,000 is recommended. This change increases the overall budget by \$6,000. In addition, trading one tandem axle truck for a semi truck with trailer would be valuable. This change increases the budget by \$8,500. These changes would increase the budget to \$124,500, modestly above the \$110,000 target. There are two other methods that John could use adjust his operations. First, he could move some land away from spring wheat and durum production. Planting crops like oats and winter wheat would help extend the planting and harvest seasons allowing the work to be completed in a timely fashion. John should also consider hiring some of the harvesting done by custom harvesters, thereby taking some pressure off himself and Kathy.

In the event that additional funding were to become available, John might consider purchasing a class VII, VIII or IX combine. While much more expensive, these combines can accommodate 36' and larger headers and travel faster in the field. Such a combine would include machines like a Case IH 2588 or Case IH 9120. In addition, two tandem axle trucks should be replaced with semi trucks.

Question 6: Return to the original farming plan, excluding the additional land suggested in question six and with both Joe and David available to work. John has been contemplating the addition of corn and sunflower production into the mix of crops grown on the farm. A retired neighbor has asked if he would like to rent 640 acres of his land for that purpose. The neighbor suggests the possibility of about 320 acres of each corn and sunflowers. John is aware that this would require him to acquire row crop farming equipment. An advantage of growing sunflowers and corn is that these crops follow a slightly different season and would not interfere with other work. How much would it cost for John to add the necessary equipment for this purpose? Please provide pictures of the recommended equipment.

Solution 6: Farming an additional 640 acres of row crops can be accommodated with a modest additional machinery investment. Three additional pieces of equipment are required: a row crop planter, a row crop cultivator and row crop headers for the combines. Fortunately, the White 2-135 tractor recommended earlier has 135 horsepower, a three point hitch and PTO. As such it should be able to work with a 12 row planter or cultivator. The recommendation is for a 1984, 12 row CASE IH 800 planter at a cost of \$5,000. In addition a 1980, John Deere RM 230 12 row cultivator costing \$2,000 should be purchased. The header recommendation is for 2, N-830 Headers for the N-7 combines costing \$3,000 each. Thus the total additional direct equipment cost necessary to add the additional 640 acres is \$13,000.

Question 7: Return to the original farming plan, excluding the additional land suggested in question six and with both Joe and David available to work. Suppose John discovers that his investments have performed much better than he was aware. Instead of having \$110,000 to spend on machinery, he has \$220,000 to spend on machinery. Develop a new machinery plan taking this new information into account. Please provide pictures of the recommended equipment.

Solution 7: In general, availability of additional funds will not affect the amount of equipment purchased. In some instances it will affect the size of equipment purchased. The additional funds will primarily be used to improve equipment quality. The improvements will be primarily in the seeding and harvesting areas.

The first change should be to purchase a better main tractor and seeder. An upgrade to a well conditioned 1988, John Deere 8850 tractor is recommended. This tractor is newer and will have about 70 additional horsepower over the International 4586. Top quality versions of these tractors with recent overhauls, newer tires and nice paint are readily available for \$30,000. This change will improve reliability and will allow the switch from a 30 foot to a 45 foot seeder. The seeder should also be upgraded from an International 8500 to a newer model. A 1999, John Deere 1850, 45 foot, seeder is recommended at a cost of \$50,000. Purchase of a more advanced seeder will increase capacity and reliability. It should also increase the quality of crops grown due to more accurate seed and fertilizer placement. The newer seeder eliminates the need for a fertilizer spreader, thereby providing a significant efficiency enhancement.

The combines should be upgraded to 1996, Gleaner R-72's. These combines with header cost about \$34,000 each. The newer combines should provide an added element of reliability and capacity. An upgrade should also occur in the truck area. One of the Chevrolet trucks should be replaced with a semi truck. Thus, the operation will have two tandem axle trucks and a semi truck. A 1989 Peterbilt, 377 semi truck costing \$6,500 and a 1977, 40 foot Timpte grain trailer costing \$8,500 are recommended for a combined cost of \$15,000. An upgrade for the service truck is recommended, increasing the cost from \$2,500 to \$5,000. Finally, two additional fuel storage tanks costing a total of \$1,000 is recommended. Table 2 provides a summary of the suggested purchases with a \$220,000 budget. The total cost of the recommended equipment is \$219,000.

Table 2: Recommended Equipment Purchases for a 4,000 Acre Grain Farm \$220,000 Budget.

ITEM	COST
1988 John Deere 8850 Tractor	\$30,000
1999, John Deere 1850, 45' Seeder	\$50,000
1978 White 2-135 tractor w/ loader, 3pt and PTO	\$8,000
2,000 Gallon Water Nurse Tank on Trailer	\$2,000
Pickup Sprayer 50', 500 Gallon	\$3,500
Summers 120' 1,000 Gallon Pull Type Sprayer	\$4,500
International 490 Disk 28'	\$3,000
Versatile 400, Self Propelled Windrower	\$2,500
2, 1996 Gleaner R-72 Combine w header	\$68,000
1977 Timpte 40', Hopper Bottom Grain Trailer	\$8,500
1989 Peterbilt 377 Semi Truck	\$6,500
2, 1973, C-70 Chevrolet Tandem Axle Trucks	\$13,000
Large Capacity Grain Auger	\$3,000
Grain Auger and Sweep	\$3,000
Service Pickup	\$5,000
Shop Equipment	\$3,500
Fuel Storage Tanks	\$2,000
MSC	\$3,000
TOTAL	\$219,000

This table shows recommended machinery purchases for a Northern Plains grain farm of 4,000 acres. The recommendation is limited to a budget of approximately \$220,000.

Question 8: Continuing with the original farming situation, how would you change the machinery plan if \$330,000 were available to purchase machinery. Please provide pictures of the recommended equipment.

Solution 8: Once again, the availability of additional funds would generally involve quality improvement as opposed to purchasing additional equipment. The bulk of the purchases will be made in the seeding and harvesting areas.

In this instance a major upgrade to the primary farm tractor is recommended. A 1998 John Deere, 9400 tractor is recommended. The John Deere 9400 will have 50 more horsepower than the John Deere 8850 and cost about \$90,000. This purchase implies a significant improvement in reliability and capacity. Further improvements are recommended in the harvesting area. The first recommendation is the purchase of a grain cart which allows for faster unloading of combines and overall improved harvesting capacity. The specific recommendation is for a Killbros 1200 grain cart, capable of transporting about 700 bushel of grain. The price of a used version of this cart is about \$10,000. A second semi and trailer is also recommended with a combined cost of \$15,000. Improvements to the tandem axle trucks are recommended. Tandem axle, lift-tag trucks have some difficulty operating on slippery surfaces which can be encountered in winter grain hauling and in fields. Changing these trucks to twin-screw trucks would be a noticeable improvement. Moreover, the gas engines in standard tandem axle trucks represent a fire concern during the harvest season. The recommendation is to replace these trucks with diesel engine, twin-screw, 1980 Chevrolet Bruin trucks that cost about \$12,000 each. Additional improvements to the service truck are suggested bringing the total cost of the truck to \$10,000. The recommended purchases are summarized in Table 3. The total cost of this equipment set is \$326,000, just under the \$330,000 limit.

Table 3: Recommended Equipment Purchases for a 4,000 Acre Grain Farm \$330,000 Budget

ITEM	COST
1988 John Deere 9400 Tractor	\$90,000
1999, John Deere 1850, 45' Seeder	\$50,000
1978 White 2-135 tractor w/ loader, 3pt and PTO	\$8,000
2,000 Gallon Water Nurse Tank on Trailer	\$2,000
Pickup Sprayer 50', 500 Gallon	\$3,500
Summers 120' 1,000 Gallon Pull Type Sprayer	\$4,500
International 490 Disk 28'	\$3,000
Versatile 400, Self Propelled Windrower	\$2,500
2, 1996 Gleaner R-72 Combine w header	\$68,000
2, 1977 Timpte 40', Hopper Bottom Grain Trailers	\$17,000
2, 1989 Peterbilt 377 Semi Trucks	\$13,000
2, 1980 Chevrolet Bruin Twin Screw Trucks	\$24,000
Killbros 1200, 700 bushel grain cart	\$10,000
13" 66' Grain Auger	\$8,000
Grain Auger and Sweep	\$3,000
Service Pickup	\$10,000
Shop Equipment	\$3,500
Fuel Storage Tanks	\$2,000
MSC	\$4,000
TOTAL	\$326,000

This table shows recommended machinery purchases for a Northern Plains grain farm of 4,000 acres. The recommendation is limited to a budget of approximately \$330,000.

Question 9: Based on the original farming plan, consider a situation where the major pieces of equipment must be less than six years old. Develop a machinery plan that includes these modern equipment purchases. Please provide pictures of the recommended equipment.

Solution 9: In order to bring the major pieces of equipment to less than six years old, the budget will increase substantially. The first change should be to purchase a 2008 John Deere 9530 tractor costing \$200,000. The seeder will be upgraded to a 48' Bourgault model 3310 costing \$190,000. This large

capacity seeder will increase seeding capacity markedly. The two sprayers noted earlier should be replaced with a self propelled John Deere 4920 sprayer. These large capacity modern day sprayers are able to spray faster and more precisely than their earlier counterparts. An improvement in the water nurse tank is also recommended bringing the cost of this piece to \$6,800. Two 2006 Case IH 2388 combines with 30 foot headers are recommended at a cost of \$155,000 each. An improvement in the unloading auger is recommended to a 13 inch diameter 71 foot length auger costing \$12,000. Finally, additional improvements are recommended for the service truck bringing the cost to \$15,000. The purchases are summarized in Table 4. The total cost of this equipment combination is \$968,800.

Table 4: Recommended Equipment Purchases for a 4,000 Acre Grain Farm with Recent Model Major Equipment Pieces

ITEM	COST
2008 John Deere 9530 Tractor	\$200,000
2008 Bourgault 3310, 48' Seeder	\$190,000
1978 White 2-135 tractor w/ loader, 3pt and PTO	\$8,000
2008, 1,700 Gallon Water Nurse Tank on Trailer	\$6,800
2005 John Deere 4920 Self Propelled Sprayer	\$145,000
International 490 Disk 28'	\$3,000
Versatile 400, Self Propelled Windrower	\$2,500
2, 2006 Case IH 2388 w header	310,000
2, 1977 Timpfe 40', Hopper Bottom Grain Trailers	\$17,000
2, 1989 Peterbilt 377 Semi Trucks	\$13,000
2, 1980 Chevrolet Bruin Twin Screw Trucks	\$24,000
Killbros 1200, 700 bushel grain cart	\$10,000
13" 71' Grain Auger	\$12,000
Grain Auger and Sweep	\$3,000
2005 Chevy Service Pickup	\$15,000
Shop Equipment	\$3,500
Fuel Storage Tanks	\$2,000
MSC	\$4,000
TOTAL	\$968,800

This table shows recommended machinery purchases for a Northern Plains grain farm of 4,000 acres. The budget is not limited, however; late model major equipment pieces are incorporated into the analysis. Specifically major pieces of equipment are all less than six years old.

Question 10: Finally, based on the original farming situation, develop a machinery plan that involves the purchase of all new equipment. Please provide pictures of the recommended equipment.

Solution 10: The purchase of all new equipment increases the total machinery cost considerably. New equipment is selected for each piece and is similar, or slightly larger in size to that recommended in Question 9. The one deviation is the Versatile 400 windrower for cutting road ditch grass is replaced with a new mower.

The recommended purchases are presented in Table 5. The total machinery cost in this case is \$2,135,800. It is interesting to note the difference in cost between the machinery purchased in this example versus the previous example. For example, the cost of the sprayer doubles in price. The cost of the same model tractor is \$90,000 more for a new model versus a one year old slightly used version. Moreover, in this example some purchases involve spending large amounts of money on equipment that, while necessary, does not receive a great deal of use. For example, each semi trucks would drive less than 10,000 miles per year. Yet the combined investment in semi trucks and trailers is \$340,000. The same applies for the Kenworth grain trucks and Krause disk.

Table 5: Recommended Equipment Purchases for a 4,000 Acre Grain Farm with All New Equipment Purchases

ITEM	COST
2009 John Deere 9530 Tractor	\$290,000
2009 John Deere 1870, 56' Seeder	\$220,000
2010 John Deere 7330 Loader Tractor w/loader 3pt and PTO	\$100,000
2008, 1,700 Gallon Water Nurse Tank on Trailer	\$6,800
2009 John Deere 4930 Self Propelled Sprayer	\$290,000
2009 Krause 7400 Disk 28'	\$35,000
2009 John Deere 285 Disk Mower	\$12,000
2, 2009 John Deere 9770 Combines w header	\$580,000
2, 2011 Timpfe 48', Hopper Bottom Grain Trailers	\$100,000
2, 2010 Freightliner 450 Horsepower Semi Trucks	\$240,000
2, 2009 Kenworth T-300 Grain Trucks	\$160,000
2009 Killbros 1950, 1,100 bushel grain cart	\$32,000
2009, 13" 71' Westfield Grain Auger	\$23,000
2009 Brandt 8" 42' Grain Auger and Sweep	\$6,500
2010 Ford Service Pickup	\$27,000
Shop Equipment	\$3,500
Fuel Storage Tanks	\$4,000
MSC	\$6,000
TOTAL	\$2,135,800

This table shows recommended machinery purchases for a Northern Plains grain farm of 4,000 acres. The recommendation is limited to recommending new equipment.

Question 11: How much money do you recommend that John spend on Machinery, \$110,000, \$220,000, \$330,000 or some other amount. Why?

Solution 11: It is not entirely clear how much money should be spent. It depends on cash availability, personal preferences, risk tolerance, willingness to repair machinery, debt load of the farm as well as tax and profitability issues. The optimal equipment plan depends in large part upon the amount of money available for the entire farm operation. If the purchase of additional equipment jeopardizes funding availability for other needs, it may be better to utilize older equipment until newer equipment is affordable. On the other hand, if sufficient funding is available for other needs, additional purchases of farm equipment might be advisable.

John should carefully consider farm profitability in making the purchases. The cost of carrying large amounts of equipment must be absorbed into farm operating costs. If excessive money is spent on equipment, the operation may not be profitable.

The \$110,000 budget is certainly a lower limit for this farm. There would be significant reliability issues, and some capacity issues associated with this machinery level. Significant improvements in reliability and capacity are achieved by increasing spending to \$220,000 or \$330,000. While spending \$968,800 or even \$2.1 million may be appealing on some levels, the necessity of these machinery levels is highly questionable for a start-up farmer. The advice is to wait with making these sort of purchases until the farming results demonstrate their affordability. Moreover, carrying cost of these machinery levels would severely limit profitability and could endanger the farm's viability. These higher levels of machinery purchases may be sensible if John was able to do custom work for other farmers to offset the costs. However, the availability of custom work is never certain, so there is considerable risk in this strategy.

Overall, if at all possible, John is advised to move from the \$110,000 level of purchases to \$220,000. The gain in reliability, capacity, and reduced maintenance costs make the additional purchases worthwhile. While less critical, a move to the \$330,000 level would also be advantageous. Equipment levels above the \$330,000 level are not recommended for John.

Question 12: Do you have any final comments or suggestions for John.

Solution 12: Yes. Prices reported here are based on equipment dealer, and private sale prices. It is not uncommon for equipment auction prices to be considerably lower than dealer prices. John might consider attending auction sales in an attempt to purchase the required machines at a lower price, or improve the quality of machines purchased while staying within the established budget.

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