Techniques and Practices of Forest Products Laboratories and Industries in the U.S.*

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(Continued from last issue)

Timber Harvesting and Grading Section

Logging and milling cost studies were the first to be undertaken. The time required to log different types of timber and the manpower involved were studied covering typical forest conditions. In these time studies, the logs of the tree cut are followed to the mills and different lumber grades sawn out of each log of the tree is accurately recorded. From these studies the log grade was evolved.

The original intent of all these studies was to solve the problem of the operators in eastern and southern states. The big operators in the Pacific Coast are capable of taking care of their own.

But about ten years ago, more and more small operators appeared on the scene cutting some of the second growth forests of the West Coast regions. So the Laboratory has to turn its attention in this direction to help these operators.

Cost and production studies have been the major job of the Laboratory, but it has already overgrown it. This work is now being done by the Forest Experiment Stations through their respective Economic and Forest Management Divisions.

Due to lack of necessary information, other than the opinion and judgment, and to the principles embodied in the methods used, the early efforts by industry and technical agencies to establish hardwood log grades fell short of desired results. In this, they made use of provisions limiting the size and frequency of defects, a method better suited for softwood log grading in which the end product is construction lumber. So the Division introduced entirely a new grading of hardwood log on the basis of clear areas between defects. This is due to the fact that former attempts at grading hardwood logs, based on the size and frequency of defects, proved unsatisfactory.

With this end in view the section conducted intensive mill studies to get basic relationships between surface characteristics of logs and the grades of lumber resulting from them without any preconceived ideas as to what the grade provisions should be. Logs of similar lumber-grade yields were carefully analyzed to determine what visible characteristics they had in common that could be used as grading factors. It was found that the principles used in grading hardwood lumber when applied to logs gave the closest correlation of any between log characteristics and lumber-grade yields. There were used in this study about 16,000 hardwood logs.

The section has now turned its attention to log grade for softwoods—the study of Douglas-fir veneer logs. There are at present grading rules used by log scaling and grading bureaus but they slightly differ from each other. There is now a concerted effort on the part of the industry, the scaling bureaus and the Laboratory to iron out these

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* Fourth of a series on the report of Prof. E. de la Cruz.

differences. A committee with adequate representation from these entities was organized to develop a uniform system of grading rules. A partial report on this work on Douglas Fir are the Log Study Progress Reports, Nos. 1 and 2. There is one coming out soon, Report No. 3.

The next step from log grading is tree grading. There is a plan being prepared that takes into consideration other factors beyond the mere quantity and quality of lumber obtainable from a tree which includes the silvicultural stand point. For example: Tree 1-A or Tree-B or Tree 2-A, etc., where 1 signifies class of lumber while A represents the silvical quality of the tree being healthy and dominant.

The work on barkers and chippers was already mentioned elsewhere in the report of the general activity of the Division, but it is this section that particularly attends to this as part of the Timber Harvesting. As a general rule, barkers of the drum type used by Pulp and paper mills can only handle 4" diameter billets. A study is now being made how to separate bark from wood after chipping for the benefit of high grade pulp producers. Kraft-mills are not bothered by this because they can use bark in tolerable quantities.

This year, this section will devote its time to the study of new barkers being developed for small mills.

For the benefit of small mill operators the section is in constant search for new development of new efficient equipment which tends to increase efficiency and minimize wastes. These are studied carefully, photographed, and a detailed report on their extraordinary performances is prepared in the form of leaflets which are distributed and given wide publicity so as to reach all those who are expected to derive profit from them.

Small Sawmill Improvement Section

About 1925, Mr. Greeley, Chief of the Forest Service, thought that there should be an agency in the Forest Service which ought to carry on an educational campaign based on the results of research studies that bring about improved cuttings and manufacture on the part of the small mills. Once these conditions are attained great benefits will also be brought to the private timber owner as well as the Government, because with the improvement in manufacture the small mill owners could sell their lumber at a much better price and therefore can afford to pay higher stumpage.

This section, therefore, is nothing more than a clearing house for improved practices which are gathered for the benefit of the small mill owners besides helping them sell their lumber through the cooperation of the extension agents of the Agricultural Department of the States. They are taught also how to pile their lumber. Whenever some things go wrong in the mills the owners are shown the right method of manufacturing to prevent production of poor grades of lumber. The men of the Laboratory keep in close touch with all new improvements on equipment that may make small mill operation efficient. Reports are made of these devices and right away brought to the attention of the small mill owners.

From time to time meetings which last two to three days are organized with the idea of bringing together the small mill owners, the State Agricultural Department agency, as well as the federal men, mainly to help the small mill owners by telling them what to do to improve their business. As this accumulate momentum, even the help of some universities and colleges are sought. Some schools of forestry are willing to put up a school for sawmilling using small mills, like Syracuse State University of South Carolina at Raleigh, and Georgia State College at Athens. There are 53,000 mills in the United States but about 50,000 belong to the category of small ones, mostly operating very poorly and are poorly financed.

The section answers numerous letters asking information on many problems even those related to what kind of saw-teeth to use and preparing a mill plan.

The Army also gets its advice from this section about mills to be used in war times. All new developments on sawmills are secured and reports made for the benefits of the small mill owners.

Just to show what other type of work the section may be called upon to do: After the New England disaster where a tremendous number of trees were blown down, the Federal government decided to organize a salvage outfit to handle the work consisting of 1,800 Forest Service men, brought in 1,953 portable mills from other states besides the 120 mills already in the states and put to bids salvaged logs to each mill. The government paid $8.00 per thousand for sawing and plus other expenses including piling, the total cost of the lumber went up to $15.00 per thousand. The sale price was $24.00 per thousand but the government possibly lost about 50 cts. per thousand. There was a total of 300 million board feet handled employing about 15,000 people. The main object of the government is to remove the fire-hazard and clear the debris which has blocked roads and other utilities so as to restore the normal functioning of the afflicted areas in the least time possible.

Studies have been made to determine the energy requirements for insert-point circular headsaws by putting a little instrument in it which made it possible to explore the amount of power it takes to saw under varying conditions which the mills might meet. The following specific points were studied in order to determine how power consumption varies with: (1) feed rate, (2) width of sawed face, (3) wood density, (4) kerf width, (5) hook angle, (6) temperature (frozen compared with unfrozen), (7) feed against tooth travel (normal) and with tooth travel (climb cutting), (8) knotty compared with clear areas, (9) saw diameter, (10) number and style of teeth, (11) dull compared with sharp saws, and (12) what gullet space is required per unit of wood removed. The immediate objectives were, first, a tabulation of horsepower requirements for circular headsaws operating within the range normally encountered; and second, the limits of cutting rate imposed by gullets: namely, the optimum ratio between gullet space required and wood removed.

Plan of work—it is proposed to explore the applicability of thin saws (circular) to say 1/8" from 3/8" and 9/32".

Wood Fuels and Burners Section

During the last fifteen years practically nothing has been done along this line of work in the Laboratory except casual inquiries about the use of wood as fuel but mostly of the complaint type—such as why creosote is developed in wood burning in hesters, or in cooking stoves.

The only work done in recent years is the development of a furnace with thermostatic control for tobacco curing barns. The main idea behind this is to encourage the use of weed-species which abounds in the tobacco region. Out of the one and one-half million barns there are about 50% of these using fuel from wood. The reason for not being able to win everybody to using wood burner is that it costs more than ordinary coal burners. But when the farmers cut their own wood, they have the distinct advantage of cheaper fuel than those using coal.

There was an effort made on the part of the Laboratory to popularize the use of sawdust as a heating fuel in these tobacco barns, but the farmers due to possible fire hazards were reluctant to use it.

While wood fuel is being replaced by oil, coal, and electricity in the cities, still the rural homes are using plenty of it and so are the industries where fuel other than wood waste is an expensive item. Wood waste may not be a deluxe fuel—except in the form of alcohol or briquets—but its irregularity, bulk, and varying moisture content are offset in many instances by its renewability, availability, and low cost. It can be logged or chipped to relatively uniform size for better handling and better fuel-bed conditions. In manufacturing plants utilizing their refuse for fuel, synchronization of production and consumption is a real advantage not lessened by the bulkiness of the fuel. Where extensive shipping and storage are involved, bulk is objectionable. No special storage tanks are required, however, as for oil, and in outdoor storage there is no risk of spontaneous combustion that often occurs with coal.

The volume of wood cut for fuel (2,002 million cubic feet a year) is second only to that cut for lumber (2,145 million cubic feet a year) and therefore merits serious consideration, not only as a drain from the Nation's forests, but also as a means of improving timber stands and salvaging waste. It is estimated that an additional 2,478 million cubic feet of wood annually wasted in making various wood products is used as fuel.

The Pacific Northwest is still a heavy user of wood as a fuel by which it produced 175 billion kilowatt hours of electric power in 1924 at an average rate of 635 kilowatt-hours per unit (200 cubic feet) of Douglas-fir waste.

Selection, Machining and Quality Evaluation Section

Some of the everyday working qualities and machining characteristics of American hardwoods have been under systematic study at the Laboratory during recent years. But unlike the physical, chemical and mechanical properties, machining properties of wood have had little systematic study and there are few publications in this field.

With the object of helping wood turners, cabinet makers, furniture manufacturers, and other wood workers, a study was made on the machining and related characteristics of a number of southern hardwoods that are practically unknown to the woodworking industries. Lack of information concerning their machining properties has been an obstacle to wider use.

The study included as far as practical the influence of some of the factors within the wood and in the various machines that affect machining results. Since such factors can be combined in literally hundreds of ways, it was impracticable to explore the possibilities of all combinations; instead, one or more sets of fairly representative working conditions were selected for each operation and applied uniformly to all woods. These of course could not be the optimum for all woods, but the results show rather what actually happens under the specified conditions.

It was expected that shipments of any given wood from different mills may vary significantly in weight, in texture, and in workability because of differences in forest and growth conditions. So in order to get a fair cross section of such variations the test samples were largely collected at 34 different sawmills scattered in selected areas from Western Virginia to Eastern Texas, the region that yields about two-thirds of the yearly cut of hardwoods. To provide some basis for comparing these less known woods with the established northern hardwoods, additional samples were obtained from one Wisconsin source. Besides, two high class cabinet woods were also included for comparison—mahogany from Central America and black walnut from Indiana, Kentucky, Tennessee, and Missouri.

For samples, 4-foot boards were used. These are considered large enough to permit making all the different machining tests on the same material. The additional data secured from these samples were: Specific gravity, number of annual growth rings per inch, cross grain, warp, and shrinkage, all of which affect either the machining or the utility of the woods.

As a criterion of workability, smoothness is considered more important than the power consumed but there is no mechanical device so far discovered that is capable of measuring smoothness of a machined surface. Instead a visual inspection was developed; each test sample was examined for machining defects and graded on a numerical scale—A grade of 5 was considered excellent, 4 good, 3 fair, 2 poor, 1 very poor, and 0 a reject.

Fifty samples of each wood were used in each test or where one kind of wood was collected in two well-established producing regions, 50 samples from each region. Data on specific gravity, number of rings per inch, and shrinkage were based on several hundred samples of each wood as a rule, including the foregoing 50 samples. The machining samples were commercial flat grain and did not include the 5% extremes of weight and number of rings per inch.

DIVISION OF TIMBER PHYSICS

Functions

1. "Plans, directs, coordinates, and conducts fundamental and applied research on the physical properties of wood including wood-liquid relations, shrinkage and swelling, electrical properties, thermal properties, plasticizing and bending, seasoning, moisture relation and control of wood in use, and training demonstration in dry kiln operation.

2. "Analyzes and interprets research data and prepares and reviews reports and publications incorporating the results of research on timber physics.

3. "Consults with technicians and other officials, both public and private, on research policies and plans on the application of the results of research on the physical properties of wood.

4. "Develops and maintains cooperative relations with public and private agencies to further research in timber physics and to advance the knowledge of the physical properties of wood."

At first, kiln drying became the principal activity of the Division which started before the 1st World War, when there was a great and urgent demand for the drying of heavy pieces of oak for frames and wheels of cannon carriages and also gunstocks. The Laboratory was called upon to tackle the problem. Then came the growing demand for drying wood for aircraft, particularly the propeller. Out of this effort, The Tieman Water-Spray Kiln was developed, the operation of which is described elsewhere in this report.

For a successful kiln drying of wood instead of natural circulation which is very slow, artificial and controlled circulation is necessary. From the different drying studies of various species of woods, the drying schedules were developed by the Laboratory.

Following the 1st World War, the use of internal-fans was developed as a necessary feature of the most modern type of dry kiln, which give more positive and more rapid air movement.

There were developed other types of dry kilns—the external blowers but the Laboratory authorities are not very enthusiastic about them.

Then came the direct gas-fired kilns which are used for drying partially dry-wood. The operation of these has been described elsewhere in this report.

In an effort to find the best and fastest method of drying lumber, Mr. Tieman experimented in the use of super-heated steam or dry steam.

The following were also tried:

Drying wood by the use of high frequency electric fields.

Drying wood by the use of infra-red light.

Drying wood by the use of vacuum.

Drying wood by the use of oscillating conditions.

Drying wood by the use of vapor drying.

Drying wood by the use of chemicals. In chemical seasoning, the chemical should be used to treat wood prior to seasoning. As in the case of southern oaks and beech which check badly, the chemical is used on green wood only on the surface. Common salt is excellent for this kind of work but very corrosive, and has the tendency to destroy the kiln. A commercial product uses common salt (90-95%) as a base but is noncorrosive. It is known as Soligna or Morton's Lumber's cure, using urea and ammonium phosphate. The principle involved in the use of chemicals is to keep the surface of the wood moist at all times during the process of drying.

Another important feature of the work of the Laboratory along kiln drying of wood is the issuance of drying schedules after they have been duly revised based on the studies made on the moisture content of different woods by the Division.

No less important is the development of an instructional course in kiln drying that became a regular feature of the Laboratory's activity after World War I and in World War II, mainly on aircraft materials drying.

To popularize the use of dry kiln all over the country, kiln drying clubs were organized in many parts of the country where members could discuss their problems and try to find proper solution to them. Oftentimes men from the Division are called upon to give talks in these clubs.

Air Drying of Lumber Section

There is no fundamental difference between air-drying and kiln drying of wood, with the exception that in air-drying there is no absolute control of the conditions prevailing in the yard. But there are three main requirements in a yard pile so as to effect a favorable air-drying:

1. Piles should be so arranged that air can get to the lumber.

2. Piles should be mechanically sound, not likely to topple over.

3. Piles should be protected from the elements.

On account of existing wide range of climatic conditions all over the United States whatever informations accumulated in air dyring remain as mere generalities and principles as they could not be of any definite value because of the different conditions prevailing in different regions and of different species. It is common knowledge, however, that softwoods dry faster than hardwoods and that the bigger the dimensions the longer it takes to dry them.

But air-drying has attained a peculiar importance as a prerequisite to final drying of hardwoods needed for saw handles, gunstocks, etc. While there have been many studies done in the Laboratory on air-drying, they are still doing studies in more specific cases. To be of any value, studies should involve a large supply of lumber, and this can only be carried out in cooperation with large companies which are willing to do most of the work and collect the data needed. So far there are few of these companies ready to undertake a cooperative project.

To illustrate what could be done to improve air-drying in a yard, the Diston people who dry woods for their saw handles usually stack their lumber for 10 months in their yard but with the strict observance of the 3 main requirements in air-drying this could be reduced materially to 3-1/2 months.

Air-drying is not only interesting but it is somewhat complicated with the appearance of the piles in packages by machine, which is different from hand-made piles, much higher, generally crowded, close to the ground, and placed horizontally. During the last three years studies in the yard have been conducted on the unit package as regards to how much space between the piles and between the rows be allowed. Packages are usually 3-1/3 to 4 feet in height and if they are intended finally for the dry-kiln they are made to suit the size of the kiln. If sufficient space is allowed between the rows and between the piles there will be more air circulation. In red-woods this is six feet between the piles but for other species it is not yet known. The big drawbacks in package piling are that there is no overhang, no pitch, and no firm foundation. At least there should be a foot clearance at the bottom of the pile and a straight passage should be left between rows like a shooting gallery.

The hand stack pile has a definite advantage in that the foundation besides being firm is given a tilt of 12 inches of pitch and a space between boards for tall piles known as chimneys.

Roofing is necessary to be placed over the piles, but this will largely depend whether it is economical to do so or not. For valuable woods it is generally done, but for cheaper woods it is not considered necessary.

No publication in this work has as yet been put out pending the completion of the project.

Moisture content of wood in use—The ideal conditions is to make wood shrink before it is put into final use, and that it must maintain its form and shape and not get out of glue joints. This is very necessary considering the fact that in the United States, usually houses are heated during cold weather so that furnitures and wood works may dry as low as 6% moisture content in the northern part while in the south 9%. Depending upon the moisture content of the air, woods in use may shrink in dry weather and swell in wet climate. So it is necessary to have the prevailing humidity determined and set the moisture content of the woods just one degree below the middle point and it will stand little swelling.

Wood bending, an ancient craft, is of key importance in many industries today—notably furniture, boats and ships, agricultural implements, tool handles, and sporting goods. Of the several methods commonly used to produce curved parts of wood, it is perhaps the cheapest, least wasteful of material, and most efficient from the standpoint of the strength of the finished part. Wood is elastic and plastic at the same time and when subjected to steam heat and wetted it will assume a new form. When a piece of wood is bent, it is stretched along the outer, or convex side of the bend and compressed along the inner, or concave side. The convex side is said to be in tension, and the concave side in compression. Wood could stand very little tension but can stand about one-third of its size in compression.

The object in bending, therefore, is to compress the wood and restrain it from stretching along the convex side. The usual method of doing this is to place a metal strap around the convex face of the piece and pressure blocks and fittings at its two ends; together the strap and pressure blocks function to prevent, or at least greatly minimize, tension in the convex side as bending force is applied.

Despite its long practical history and advantage over other methods, however, there is no method of wood bending that guarantees 100% success. Long experience has evolved practical bending techniques, and skilled craftsmen apply them. Yet commercial operators are often plagued with serious losses due to breakage during the bending operation or the fixing process that follows. There is a long felt need for more reliable knowledge about such factors as (1) selection of bending stock, (2) seasoning and plasticizing of wood to prepare it for bending, (3) efficient machines for the bending operation, (4) drying and fixing the bent part to the desired shape, and (5) the effect of bending on the strength properties of wood.

Moisture Effects in Buildings Section

This section is chiefly concerned at first with what are the suitable moisture contents of wood that go to constitute the different parts of the building or house. When unseasoned framing lumber is used, subsequent shrinkage may result in excessive plaster cracks, distortion of door and window openings, the binding of moving parts, doors that will not latch, loosening of nails that weakens the structure, pulling of fastenings, openings and cracks that permit air infiltration, decay hazards, and other defects too numerous to mention but which add to upkeep, disfigurement and annoyance. This is true when drying facilities were still meagre or because the people were not aware of the importance of using seasoned lumber, a practice very common in the Philippines today, inspite of the availability of seasoned lumber in the market.

The situation in the United States during the war emergency period and even after the war made it almost imperative to use any kind of wood available to meet the tremendous demands for housing that grew entirely out of proportion. Great was the demand that most buildings have been constructed of framing lumber that has not been adequately seasoned. In fact, in some cases, it was almost as green when it was installed as when it came out of the sawmill. Above the floor level this material gradually dried out after erection and developed the usual defects expected from unseasoned lumber. Over basementless structures the floor beams and joists sometimes did not dry out, decay set in within a few months, and expensive repairs were necessary.

Construction materials are divided into two classes: (1) those which constitute the framing classed as yard lumber—beams, joists, studs, rafters, and sheathing; and (2) those that are classed as finishing lumber—flooring, finish, trim, doors, and windows. Those in group (1) are mostly and customarily air-dried, while all (2) finishing lumber should be kiln dried. This difference in seasoning practice is largely a matter of expediency, since it is possible to kiln-dry framing lumber in items up to 2 inches thick if suitable kilns in adequate numbers are available.

The study of factors connected with moisture condensation came in later. This work was not treated as research at first but was a great deal educational in nature.

Twenty-five to thirty years ago, or sometime before the depression, houses were made much bigger, more roomy and not as air tight as they are now. At that time too, the paints used were of much better grade, with 100% white lead as base. Besides, the type of construction in vogue with sufficient overhang at the eaves around the edge of the entire house roof afforded plenty of protection to the outside walls. Paint failures could hardly be found anywhere.

Then came the modernization of the home which involved changes not only in its appearance, but in size, in the insulation of its walls, and even in its heating devices. The eaves were eliminated, the big house became much smaller and made more compact, better insulated, no more fireplace which was used largely as a decorative feature yet a very important factor in home ventilation replaced by modern electric or oil burners, and even the paint, being of lower grade base with hardly 35% white lead. All these changes were effected in the effort of lowering the cost of the home for the low income masses. This is particularly true in all Federal Housing projects where the contractors were bent to reduce the cost of the houses just to increase their profits.

Considering the fact that in the so-called modern homes, people continue to do their house chores—like cooking, washing, bathing, etc., proportionately there is more moisture inside the small well-sealed house than in the old type which is bigger.

The condensation problem is not new, always having been rather common in barns during severe winter weather, but only in recent years has it become a general problem in houses. Water stains on walls and ceilings are the common signs of this condensation, but often the damage is more serious. Stain and decay in sheathing, studs, and roof members; loosened plaster; outside paint failures on siding, and door and window trim; and afforescence on brick and stone are frequently the result of this condensation. The question naturally arises as to why condensation should be more of a problem today than it used to be. It may look strange because these were brought about, as has been pointed above, by the improvements introduced in the houses to increase the comfort of the occupants and decrease the operating expenses.

We who live in a tropical climate are not confronted by this problem. But in the United States the problem of condensation of moisture in their houses occasioned by the cold climate prevailing during winter months

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FOREST EXPLOITATION . . .

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tation of logs to Japan be limited to what that country needs for local use.

In order to help in the conservation of our forest and insure the stability of the lumber industry, it is recommended that (1) selective method of cutting should be applied on permanent forest lands where conditions warrant; (2) reduce and utilize wastes in logging and sawmilling through improved methods of manufacture and by establishing a system of integrated industries; (3) lessen the drain on our forest through the use of less popular but just as good wood and by means of wood preservation; (4) conduct studies on the chemical and physical properties of woods through the Forest Products Laboratory; and (5) limit exportation of logs to Japan to at least what that country actually needs for her local use.

TECHNIQUES AND . . .

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still remains to be a serious one. Millions of dollars are spent every year on painting, decorating, maintenance, and repairs, because of disfigurement and damage caused by cold weather condensation.

Another problem which this section has been doing a lot of work in preliminary studies is how to prevent water entering between outside wall sidings caused by capillarity. It has not been only causing failures in paints but has also been the root cause of decay, thereby shortening the life of the building.

Thermal insulation is another study that is considered of great importance because of the peculiarly cold climate during winter and the exceedingly hot weather during summer. To make the houses as comfortable as possible during the period of climatic extremes the houses should be properly insulated.

The inflow of heat through outside walls and roofs in hot weather or its outflow during cold weather has important effects not only on the occupants but also on the furniture and fixtures as well as the building materials of the house. Besides, during cold weather, such heat flow also governs fuel consumption to a great extent. Most structural and finishing materials used in building are low in resistance to heat transmission. Hence, the necessity for the use of insulating materials to be incorporated in exterior walls, ceilings, and floors so as to increase resistance to heat passage.

(*To be continued*)

REFORESTATION WITH . . .

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estation projects. It is, therefore, to the best interest of the public if the reforestation projects be removed from the responsibility and supervision of the District Foresters and be placed under the five Supervising Foresters who should devote their full time supervising the projects under them. These Supervisors will in turn be responsible to the Director of Forestry through the Chief, Division of Reclamation and Reforestation. This set-up will reduce the span of control, hence less red tape and better efficiency.

EXCERPTS AND . . .

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diameter of the tree above buttress becomes bigger; (2) The damage in felling increases as the tree grows taller; (3) The damage in felling increases with the volume of the tree; (4) The damage in felling increases with the per cent of slope if the trees are felled downslope; (5) The damage in felling largely occurs in the unmerchantable tops with a ratio of 1 per cent damage for every 2 per cent in the unmerchantable top; and (6) The damage in bucking is low and negligible. These findings may not be applicable to all cases since conditions in different places are different.

—P. D. Bautista

A good reputation; a clear conscience; appreciation of nature; a peaceful heart; the knowledge of having given happiness to others; a trained and well-filled mind; satisfaction from duty well done; faith in the outcome of right; contentment; well-adjusted social relationship: these make for true happiness.