Extension Education Methods

Producing Print-on-demand Publications for Instructional and Extension Materials

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Summary. Print-on-demand (POD) publications are being produced from computer to printer to increase the diversity of printed extension and educational materials. The layouts are stored in libraries on the computer and text files and digital images are added to the layouts. Images can be edited before insertion into the layouts to enhance the image. The completed materials are stored in portable document format (PDF) on disk and are printed as needed or distributed over computer networks. Printing materials as needed greatly increases the diversity of materials and gives greater flexibility in revising publications than bulk printing.

The basic system for producing print-on-demand (POD) publications consists of a computer, a mass storage device, and a printer (Table 1). Depending on the source of images, other equipment may be needed.

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There are a variety of computer programs for editing digital images and for developing layouts. Different ways of producing these publications have been explored at the Univ. of Guam. Digital images from different sources were compared for ease of use and resolution. This paper describes our experiences and the basics of producing POD publications.

Several methods are used to acquire images. Photo CDs are a source of high-resolution images scanned from film, but more time is needed to obtain the images because of commercial processing. With live video capture, a video camera is connected directly to a computer, and images are digitized in real time. Tape-recorded images also can be used, but the image quality is poorer than that of live video. Digital cameras are very useful sources of digital images.

High-resolution digital images in formats usable on computers are now commonly available (Pihlak et al., 1993). These images are incorporated easily into publications on the computer, resulting in the production of printed materials with color and monochrome pictures. Potentially, there is a large volume of printed material that is of value to smaller audiences, e.g., workshops, classes, and individual clientele, but it is not practical or economical to produce and store bulk printings. Electronically stored publications can be printed as needed to satisfy the above-mentioned audiences. These POD publications make it feasible to produce and maintain the lower-demand printed materials. POD publications are being produced at the Univ. of Guam for use as extension fact sheets, classroom materials, and posters (McConnell et al., 1993; McConnell and Marutani, 1994). Figures 1 and 2 are examples of recent POD publications.

POD materials can be produced in a relatively short time. For example, a handout for an orchid workshop was produced between sessions during a 1-day workshop. During a break after the first session, images that showed how to repot orchids were digitized from a video recording. The pictures were incorporated into a layout of a handout, with text describing the photos. The completed layout was

Table 1. Equipment needed for a print-on-demand (POD) system.

Components	Notes
Minimal basic equipment	
• Computer	Should have sufficient memory (RAM) for working with digital graphics (24 MB minimum, ≥50 MB recommended).
• Mass storage device	Large capacity is recommended (2 GB minimum).
• Printer	Can use any printer. Color is a useful feature (minimum of 300 dpi resolution). Optional equipment depending on method of image acquisition
• CD drive	Used with photo CDs.
• Video capture board	Used to connect video camera to computer. Generally used to digitize three-dimensional objects, but can also digitize two-dimensional images.
• Scanners	Available as film and flat bed. Used to digitize media.
• Digital camera	Produce instant digital images

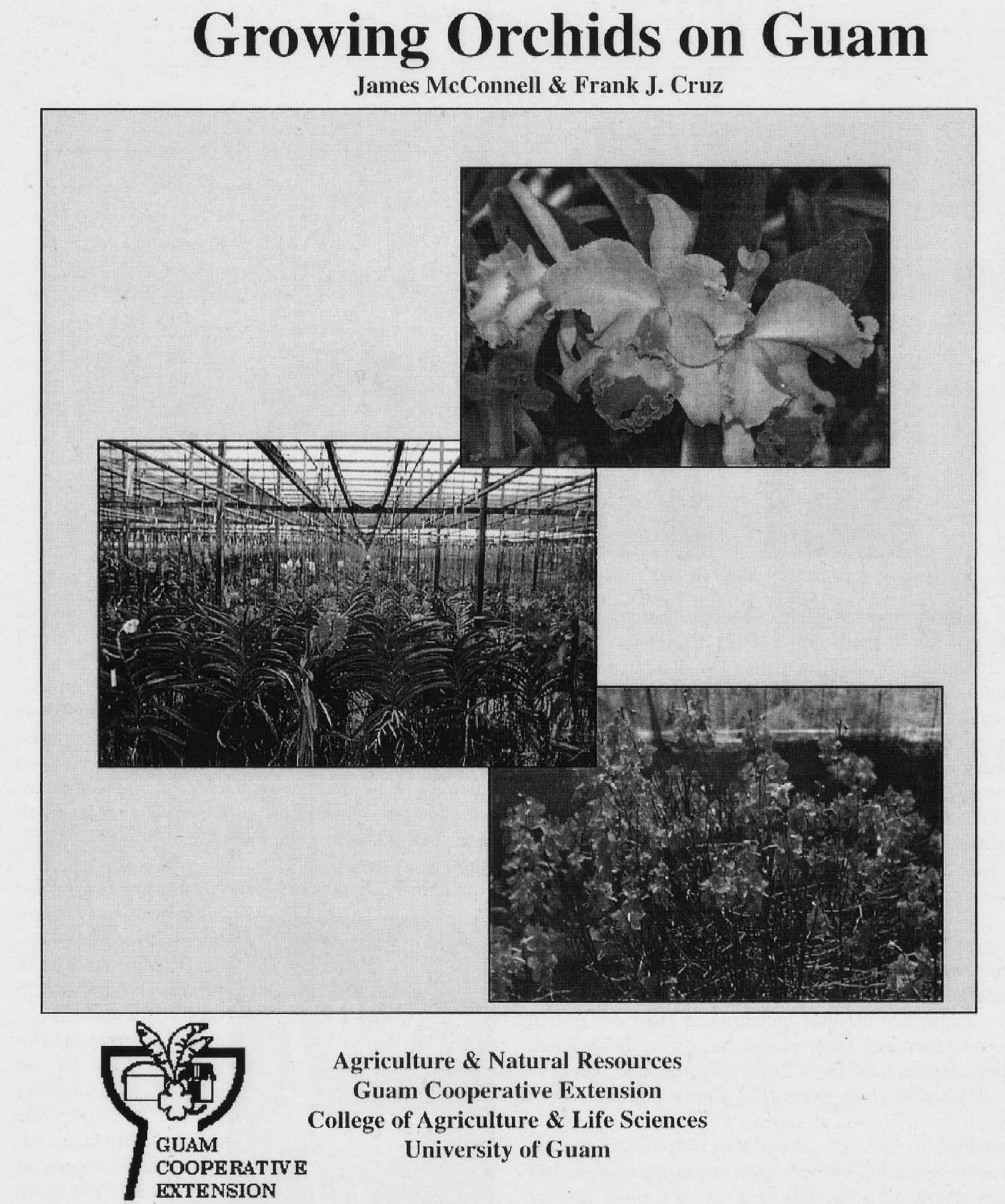


Fig. 1. A cover of a booklet produced as a print-on-demand (POD) publication. The photographs were produced by slide scanning.

AGFAXTS Ornamental Notes 96-1

Agriculture and Natural Resources, Guam Cooperative Extension, College of Agriculture and Life Sciences, University of Guam, Mangilao, GU

Heliconias

Heliconia caribaea **Lamarck cv. Purpurea**

Heliconias are native to Central and South America and islands of the South Pacific. Heliconias (Family Heliconiaceae), along with Bird-of-Paradise (Family Strelitziaceae), Gingers (Family Zingiberaceae), Costus (Family Costaceae) and Cannas (Family Cannaceae) are relatives of Bananas (Family Musaceae). Many of these closely related plants are grown as ornamentals. Most have large leaves, often with long petioles and large showy flowers commonly with one or more colorful bracts. Most heliconias are well adapted to the humid lowland tropics. They are easy to grow and produce a brilliant show of color. Many cultivars have long lasting flowers which make excellent cut flowers.

Heliconias produce rhizomes (underground stems) and erect shoots (See Fig. 2). The rhizomes branch off and produce new shoots. New branches and shoots develop from buds or eyes on the rhizomes. The shoots are composed of overlapping leaf sheaths which make up the above ground pseudostem and support the large leaf blades and inflorescences (clusters of flowers). Some heliconias have erect leaves with long petioles like bananas (musoid), others have horizontal leaves with short petioles resembling gingers (zingiberoid), some are intermediate with short to medium petioles supporting leaves at about a forty degree angle, like cannas (cannoid). The inflorescences are either erect or pendent with showy bracts containing varying numbers of small flowers.

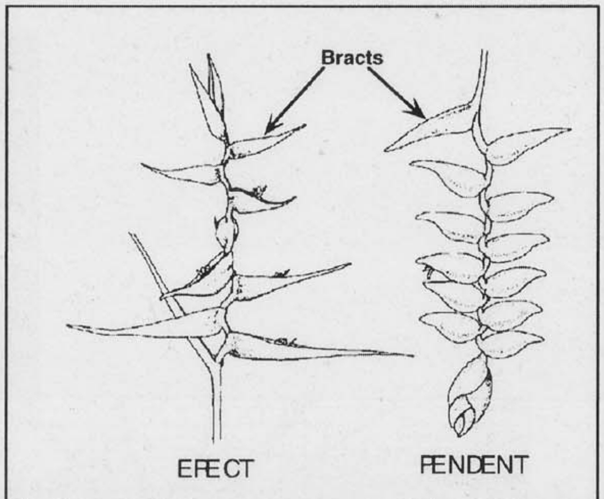
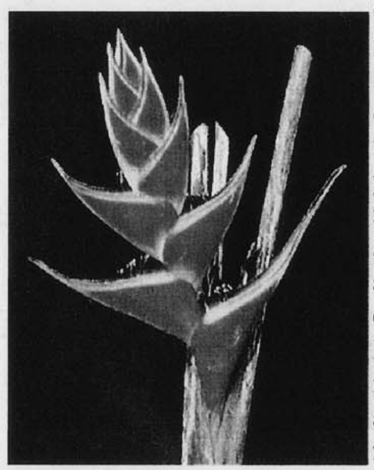


Fig. 1. Typical inflorescence characteristics of Heliconia.

Growing Heliconias

Heliconias like lots of water, well-drained soils rich in organic matter and sunlight. Heliconias do not grow well in standing water. A good growing medium can be made using equal parts soil, wood chip mulch, and peat moss. This mix can be used for starting heliconias in a pot and also can be added to the hole when planting in the ground. Fertilize with a complete garden fertilizer at least every two months. Follow the manufacturer's recommendations. Heliconias grown in alkaline conditions (high pH) will often produce yellow to white new leaves typical of iron deficiency.

Most species of heliconias require lots of space and can spread across an area in all directions. The larger species such as *H. caribaea* can grow to 25 feet in height. When planting, space the rhizomes at least 15 feet apart. Smaller species such as *H. psittacorum* can be planted closer. Allow some open space for it to spread. Dead leaves and old stems that have finished flowering should be removed.



Heliconia stricta **Huber**

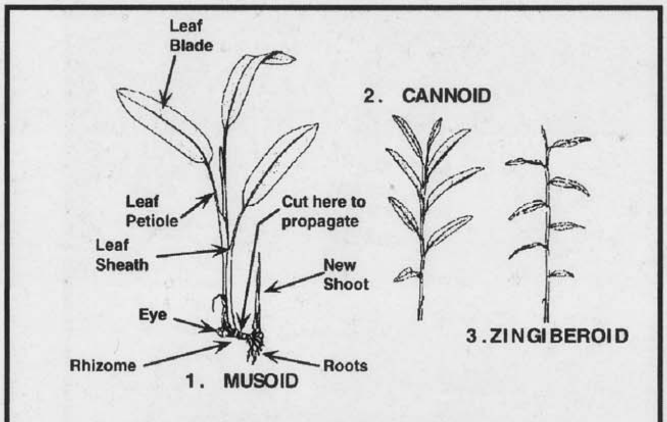
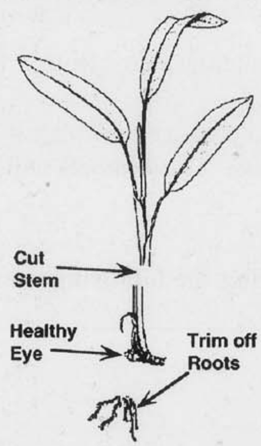


Figure 2. Three basic growth habits of heliconia.

Propagating Heliconias

Heliconias are most easily propagated by dividing the rhizomes. Look at the clump and identify the most recent growths. The most recent growths will have several eyes from which new shoots will develop. Rhizomes are divided by cutting the stem behind a recent growth.

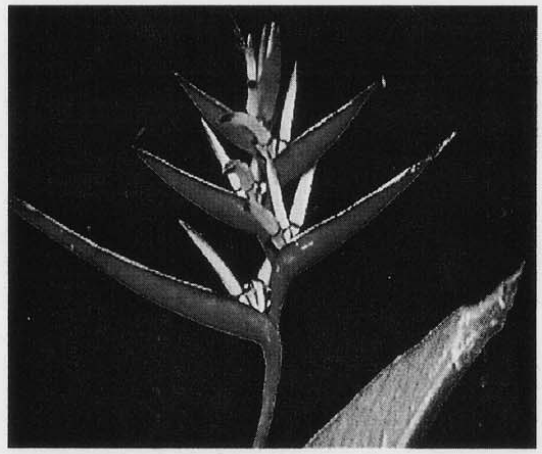


After cutting the rhizome, dig out the growth and cut off the stem, leaving about 1 foot. Make sure that there is a healthy eye on each division. Wash the rhizome and remove the roots. Plant in the smallest pot the rhizome fits in loosely. Place the rhizome in moist soil/organic matter mix. Plant with the eye near the surface of the soil. Place in a shady location, keeping the soil moist. Transfer to the appropriate light condition for each cultivar after the first leaf has fully expanded.

Pests

The most common pests are mealybugs, scales and nematodes. The mealybugs and scales can be controlled with an insecticidal soap.

Nematodes are small worms that attack the roots. Due to nematode problems, heliconias require replanting every few years from healthy rhizomes. The roots must be removed to prevent the spread of nematodes.

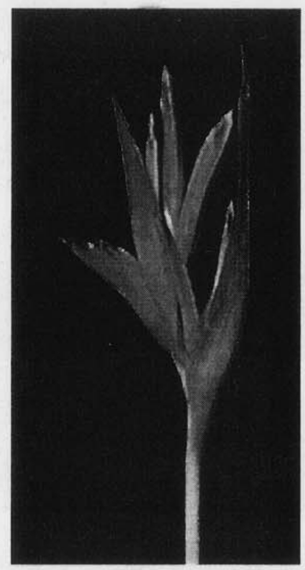


***Heliconia hirsuta* L.f.**

Common Names of Representative Species

Common Name	Species
Parrot's Beak	*H. psittacorum* 'Rubra'
Giant Lobster Claw	*H. caribaea*
Hanging Lobster Claw	*H. rostrata*
Small Lobster Claw	*H. stricta*

***Heliconia rostrata* Ruiz & Pavon**



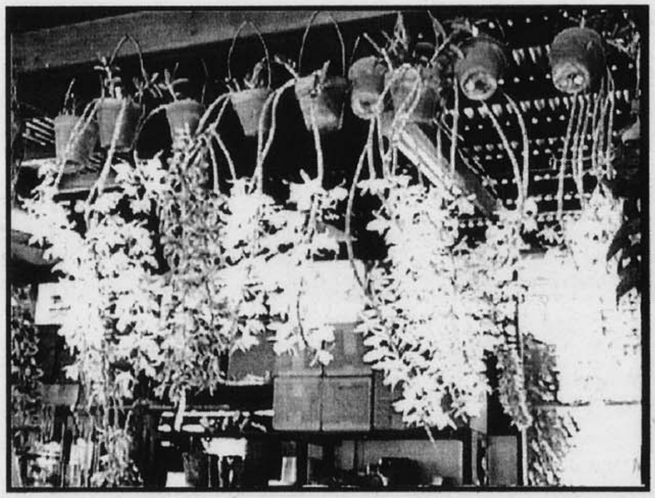
***Heliconia psittacorum* L. f. cv. Rubra**

Prepared by James McConnell and Frank J. Cruz, Horticulturists at the University of Guam

Issued in furtherance of Cooperative Extension Work, Acts of May 8, and June 30, 1914, in cooperation with the United States Department of Agriculture (USDA. Jeff D. T. Barcinas, Dean/Director, College of Agriculture and Life Sciences, Cooperative Extension System, University of Guam, UOG Station, Mangilao, Guam 96923. "The programs of the University of Guam Cooperative Extension are open to all regardless of age, race, color, national origin, religion, sex, or disability." Reference to product names does not imply approval or recommendation of such products by the University of Guam to the exclusion of others that may be equally suitable.

Fig. 2. A print-on-demand (POD) fact sheet. The photographs were made by video capture.

Growing Honohono Orchids.

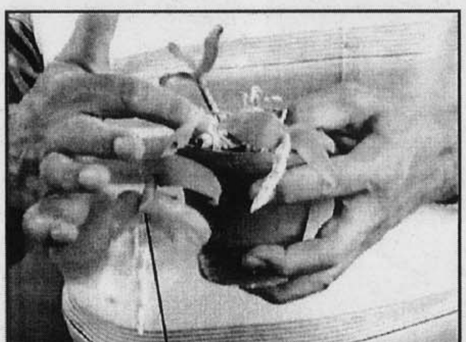


Scientific Name and Synonyms:

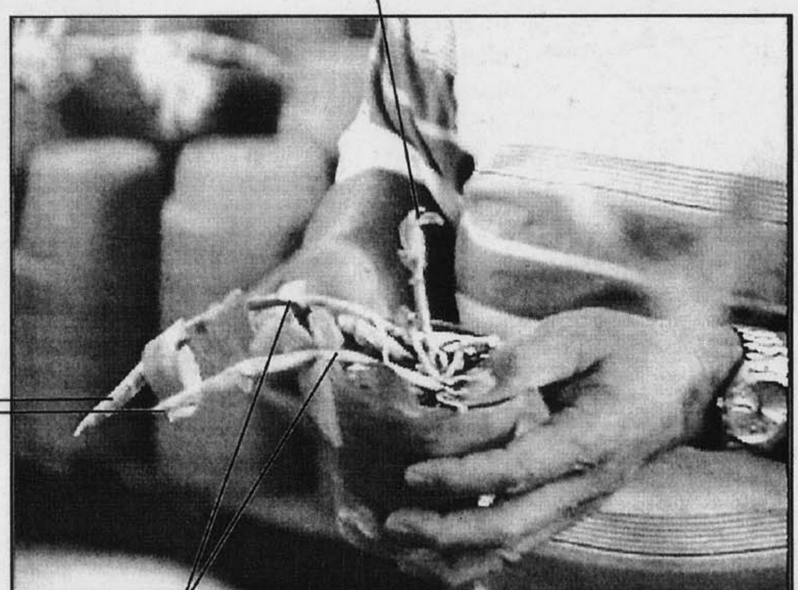
Dendrobium anosmum Lindl.
(Syn. *D. macrophyllum* Lindl.
D. macranthum Hook.
D. superbum Reichb.f.)

This beautiful orchid species is one of the most widely grown species of *Dendrobium*. It has been found in the Philippines, Sri Lanka, and throughout the Malay Peninsula. The stems are thick and pendulous reaching lengths of 1-3 meters. The leaves are deciduous and drop from the growths each year. The flowers appear in pairs along the length of the stems. The flowers range from deep magenta purple to white. It grows best in a hanging pot or basket. The following are some general guidelines for caring for this species.

1. Starting in February (when new growths appear), water regularly and feed with 30-10-10 fertilizer.
2. Beginning in July, water regularly and fertilize with 10-30-20.
3. Around November 24, stop watering almost completely. Water only enough to prevent the stems from shriveling. Continue this until after flowering.
4. After flowering, trim off the stems which have flowered. These stems can be used to produce new plants. There will be new shoots on the original plant which should be cared for as described here. These shoots will grow long and flower in the coming year.



Flowers will form on this stem during the following year.



Current season's flowers will appear on these stems.

Cut these stems after they flower and use for making new plants by placing on some growing medium.

Portions of this handout are from a workshop conducted by Calvin Miyamoto. Handout produced by James McConnell.(April, 1993)

Fig. 3. A print-on-demand (POD) flyer produced between workshop sessions using video capture to produce the images.

printed in time for the next session later the same day (Fig. 3). Printing on demand also makes timely revisions practical, since copies are printed as needed, resulting in less inventory of old copies of a publication.

Steps in developing POD publications

The steps in developing POD materials are illustrated in Fig. 4. They include developing text and graphics, obtaining images, editing images, and developing layouts. The first step is to type the text using a word-processing, desktop-publishing, or drawing program. Graphics or figures, including line drawings and various charts, can be produced from statistics or drawing programs. The text and graphics must be saved in formats that are compatible with the program in which the final layout will be made. In some publications, the use of the graphics may suffice without the use of digital images.

Obtaining images

Images to be added to the layout can be obtained from video, scanning, or digital cameras. The choice of digital image source depends on the quality of image needed for the publication and resources available. Methods for obtaining images vary in quality and in speed of capturing the image (Table 2). There are different costs for equipment and labor associated with the various methods. This section describes some of the characteristics of images from various sources.

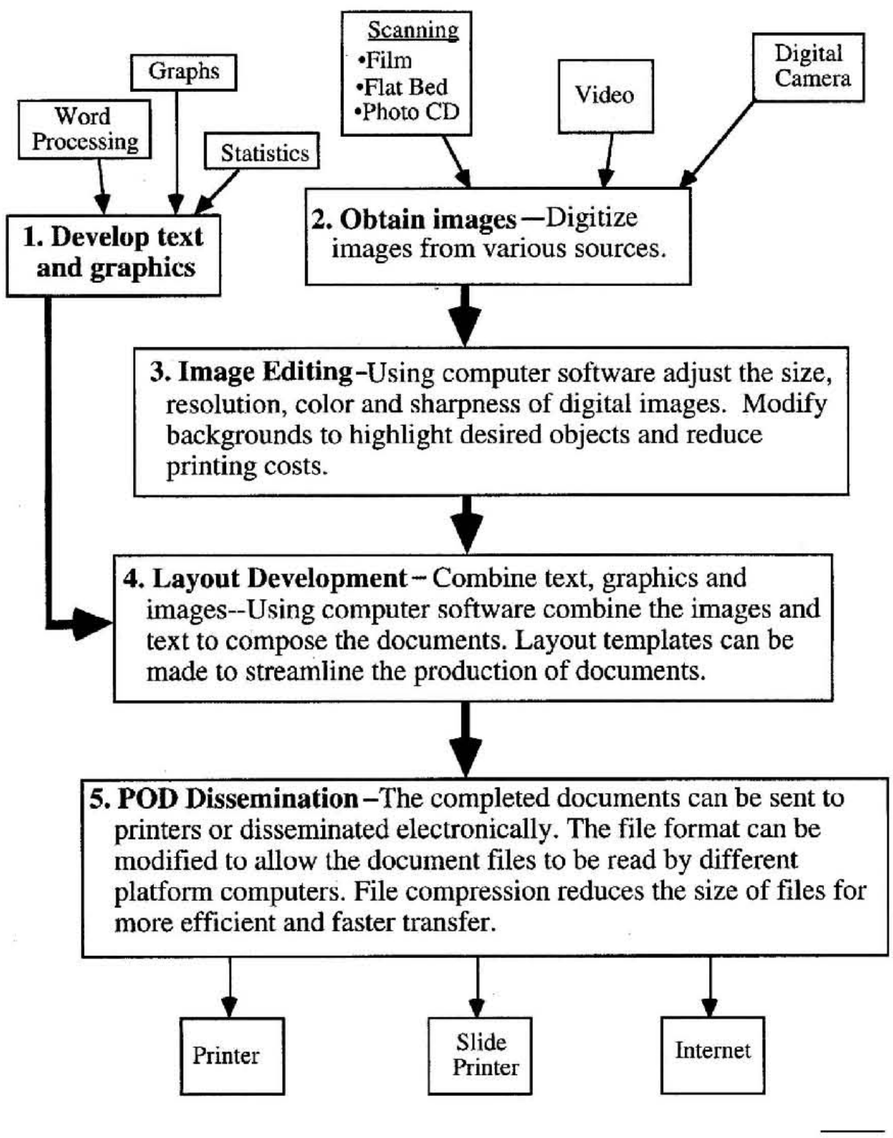
Video images. Video capture requires several pieces of equipment—a video camera, a video-capture board, and the cables for connecting the camera to the computer. The resolution of video-captured images is low—72 dots/inch (dpi), but video capture has many strengths, including the fast turnaround from capturing the image to final digital image. The time to digitize an image is relatively short—less than 3 min/picture to capture the image and save to disk. The actual time varies with specific equipment. Live capture has the fastest turnaround, and one can see images as they are captured on the computer monitor. This helps to obtain the best possible lighting to show desired features in the image. Images can also be videotaped away from the computer by recording images to tape. The images can then be digitized on playback into the computer, but this reduces image quality compared to live-image captures.

Video images can be used to obtain photos quickly for a fact sheet, thus expediting the production of the publication. For example, to release information on a disease outbreak, one could shoot video images quickly and incorporate these into a document layout. Later, higher-quality images from a photo CD or film scan could be used to replace the video images.

The quality of the image varies greatly with the type of video-capture board and the video source. High-quality images can be obtained from laser discs with a resolution of 450 scan lines. Video camera formats—Hi8 and Super VHS—have a resolution of 400 scan lines, and standard VHS has a resolution of only 240 scan lines. Using an S-video connection from the camera to the video-capture board produces a more discrete image because the chrominance and luminance signals are separated. The composite signal mixes the two signals, which results in fuzzy images (McClelland, 1993). The board also must have an S-video connection. The best-quality image also requires a video-capture board capable of digitizing 24-bit pictures.

Images consist of many dots or pixels. The number of dots determines the resolution of the image. A typical Macintosh 13- or 14-inch monitor has a resolution of 640 × 480 pixels. A 17-inch monitor has a resolution of 1280 × 1024 pixels. An IBM-compatible VGA monitor has a resolution of 640 × 480 pixels. A Super VGA monitor has a resolution of 800 × 600 pixels. The number of pixels that can

Fig. 4. Steps for producing and disseminating publications with a print-on-demand (POD) system.



be generated with a video camera is much less than with film. Current high-quality video cameras have ≈410,000 pixels/image. Films used in still cameras have millions of pixels per image. Video picture quality can be improved by capturing the image as a full-screen (13-inch) image. During image manipulation, the picture size is reduced, while the resolution is increased from 72 pixels/inch (ppi) to a higher resolution. For example 120 ppi resolution gives the best-quality printout using a 360-dpi printer. For a 600-dpi printer, the optimum resolutions are 150 or 200 ppi. Printers that print at higher resolutions require higher resolutions. There is a limit to how much the image can be improved by reducing image size.

Video captures work best for closeups. A basic guideline is to use video for objects covering ≤3 m^2. Because of the limited number of pixels, pictures of larger areas do not show much detail. With field shots, there are relatively few pixels imaging each individual object.

Video capture gives the ability to adjust the color balance, contrast, brightness, and sharpness while viewing the image on the computer screen before capturing the image. This greatly enhances the conveyance of the desired information of an object. The lighting also can be adjusted while viewing the image to highlight objects in the image.

Certain models of video cameras have other useful features. For example, there are models that allow the aperture to be adjusted, thus increasing the depth of field. This allows more of the object to be in focus. There are also camera models that have adapters that allow the use of still-camera telephoto macrolenses. This makes it possible to use the video camera as a dissecting microscope. Figure 5 shows a fact sheet with closeup shots of root nodules. The lighting was adjusted while viewing the images on the computer screen.

Magnifications capable of viewing nematode-sized images are possible. Video capture produced closeup images for fact sheets on fleas and white flies. To achieve this magnification requires a 100-mm macrolens with high-power closeup diopters. Spherical aberration is generally not a problem, because only the center portion of the lens is used by the charge-coupled device (CCD) in the video camera. When these lenses are used with film, the outer circumference of the lens often shows distortions.

Video capture can be used to digitize printed materials such as magazines, books newspapers, films, and three-dimensional objects. It is sometimes possible to see printing dots or film grain in closeup pictures.

IMAGES FROM SCANNING. Scanning digitizes an image from an existing medium, most commonly paper or film.

Flat-bed scanners have been available for many years in black and white format. Color scanners are now available for less than $1000. The resolution of color scanners ranges from 72 to 600 dpi. Scanners commonly include software that allows interpolated resolution up to 3000 dpi. Some flat-bed scanners come with attachments to scan slides. Generally, the quality obtained from scanning film on a flat-bed scanner is much lower than with a film scanner. Flat-bed scannings generally require 3 to 5 min/picture, including the time to save the image to disk.

Most film scanners are designed for 35-mm film, and many scanners are designed to work with mounted slides. Print films can be inserted into slide mounts, and the image can be inverted after scanning. The resolution of the film-scanned digital images can be very high. In most cases, the needed resolution to display the image on a computer monitor or for printing is much less. The higher the resolution of the scan, the longer the scanning process and the greater the amount of disk storage space required. Also, the computer will need greater amounts of RAM to work with higher resolution images. One must also keep in mind image size. In general, the image size used in printed materials will have a length of 3 to 20 cm. When deciding on a picture resolution, set it as required for the final printing.

Film processors have developed their own methods of digitizing images to disk. The resolution ranges from moderate to high. These are basically film images that have been

Table 2. Comparison of image sources.

Source	Comments
Video	Fast method of getting images. Lowest resolution. Not good for wide angle of fields. Best when using live video. Requires video camera and video-capture board. Many newer computers have video-capture boards. Pictures can be previewed before capture.
Flat-bed scanner	Fairly high resolution. Requires purchase of scanner.
Film scanner	Requires purchase of scanner. High resolution. Slow, labor intensive method.
Commercial film scanning	High resolution (closest to film resolution) to photo CD. Delays because of sending for processing. Images are archived on CD; therefore, they do hard disk space.
Commercial film scanning to floppy disk	Not good for archival storage of images. Resolution not as high as photo CDs. No equipment investment other than computer.
Digital camera	Fastest method of obtaining digital images. Easy method. High-resolution cameras are expensive, but prices are decreasing.

Agdex 306/05

AG FAXTS — ***VEGGIE FLASH 94-2***

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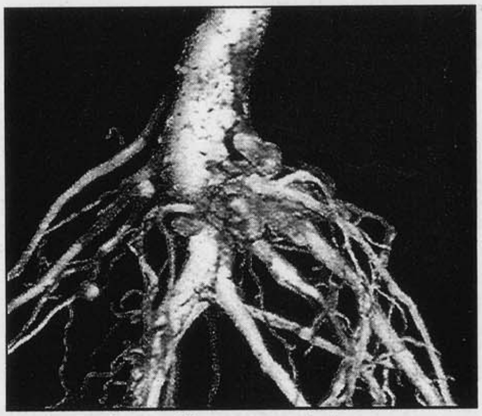
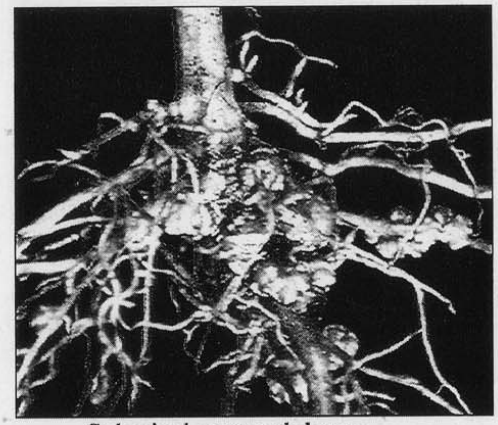
LEGUMES MAKE N FERTILIZER FROM AIR

BIOLOGICAL NITROGEN FIXATION

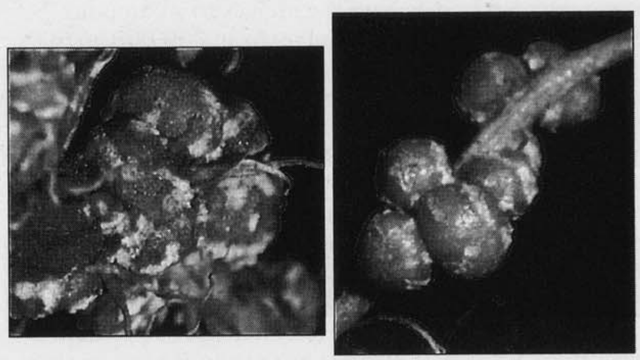


Finger-like root nodules on sunnhemp (*Crotalaria juncea*).



Spherical root nodules on mungbean (*Vigna radiata*).

Close-up of root nodules on sunnhemp.



Close-up of root nodules of mungbean.

Nitrogen (N) is an essential element for all living organisms and nitrogen is the main component of the atmosphere on earth. Nitrogen moves in a cycle from the atmosphere into the soil and plants, through the food chain of animals and man, and back to the atmosphere. **Protein** is the principle nitrogen compound that has an important role in the growth and development of plants and animals. One group of **bacteria** called **rhizobia** are able to convert the atmospheric nitrogen (N_2 gas) to ammonia (NH_3) within root **nodules** of **legumes**. This process is called **biological nitrogen fixation** (**BNF**). Nodules are small, knob-like outgrowths on roots of some legumes. In nodules, the ammonia is converted to amino acids. These amino acids are then transported out of the nodules to other parts of the host plant where the N compounds undergo further changes, mainly to produce proteins. Biological nitrogen fixation is a type of **symbiosis** resulting in benefits to both plants and bacteria. A major advantage of some legumes, especially forage legumes, in agriculture is that they can increase the nitrogen content of the soil and contribute to the nitrogen yield of companion or subsequent crops. Legumes with BNF have been used in crop rotation, as green manure and cover crop and in alley cropping systems.

M. Marutani, E. Manalastas and J. McConnell———GCE Publication # 94-2. 1994.

The Guam Cooperative Extension. Issued in furtherence of Cooperative Extension Work, Acts of May 8, and June 30, 1914, in cooperation with the United States Department of Agriculture. C.T. Lee, Dean/Director, College of Agriculture and Life Sciences, Cooperative Extension System, University of Guam,UOG Station, Mangilao, Guam 96923. "The programs of the University of Guam Cooperative Extension are open to all regardless of age, race, color, national origin, religion, sex, or disability." This project was funded by USDA Special Grants Program for Tropical and Subtropical Agriculture Research 92-34135-7285.

Fig. 5. A fact sheet with digitized closeup video images. The images were viewed in real time on the computer screen, allowing adjustment of the lighting.

scanned, compressed, and stored to 3.5-inch disks. The images can be digitized from either slide or print film. The cost ranges from $0.70 to $1.20/photograph.

The photo CD also is a digital image scanned from film. The standard photo CD has images digitized at five different resolutions. The actual images on a photo CD all are digitized at 72 dpi. The size of the images range from the actual size on the film up to poster-size images. The highest-resolution format requires large amounts of memory to open the files (>45 megabytes are needed). Working with the higher-resolution images is very time-consuming, and the images take large amounts of disk space. The best use of high-resolution images is to detail closeups of specific items in an image. These can be used in conjunction with the wider-angle images to present two different viewpoints. Using image-manipulation software, the resolution can be increased while decreasing the size of the image, resulting in higher resolution for printing.

The benefit of using a commercial company for scanning images is 2-fold: first, the digitizing process has no direct labor, and second, there is greater consistency among images.

IMAGES FROM DIGITAL CAMERAS. Digital cameras have moved to the forefront for desktop publishing. There are many models available and the resolutions have increased. Many cameras often include image editing software and the necessary cables for transferring the images to a computer. The resolution of digital cameras ranges from 300,000 up to 140,000,000 pixels. The storage systems can be RAM chips, floppy disks, or hard drives. Some of the cameras require a cable to transfer the images to a computer. Most commonly the cameras connect to serial or SCSI ports.

The first cameras cost $10,000 and were of relatively low resolution. Resolution continues to increase and cameras are now available at a lower cost. The higher-resolution digital cameras still cost $8,000 to $40,000; however, there are lower-resolution cameras that produce good-quality pictures available for about $900. Rodney (1997b) found that the current lower-cost cameras had resolutions ranging from 640 × 480 to 1024 × 768 ppi. This resolution is suitable for Web publishing and for small pictures for print media. Using digital cameras is easy, fast, and little correction is needed. These cameras can produce quality transparencies and 8 × 10 prints. Some of the lower-priced cameras have set amounts of RAM, which limits the number of pictures that can be stored. Pictures may be compressed to save space, but this degrades the image.

High-resolution digital cameras are expensive and are more difficult to use than the lower-resolution cameras. Many of the high-end cameras were originally designed as 35-mm cameras fitted with a CCD and mass storage. An advantage is the flexibility of interchangeable lenses, high speed processing, and more powerful flash options. But we have found determining the proper exposure more difficult. The CCDs are smaller than 35-mm film. This makes matrix metering nonfunctional. Only spot and center-weighted metering works. For film photography, 50 mm is the normal lens size. On the digital model, a 16- to 18-mm lens is needed for a normal field of view. Focal lengths of 50 mm become telephoto lenses. While this characteristic enhances the cameras capabilities for closeup photography, wide-angle shots are difficult. You have to move far away from the subject to get a whole picture. The distance between the subject and the camera is greater, allowing more flexibility in lighting. There is also less chance of disturbing living subjects (insects). These cameras also have common lens mounts that allow them to be attached directly to equipment such as microscopes.

Other common features of digital cameras include the ability to control the shutter through the computer. This allows the camera to be controlled by voice commands to the computer.

A new generation of professional digital cameras is becoming available. According to Rodney (1997a), these cameras can be grouped into three types: scanning, instantaneous capture, and multi-exposure capture. Each type of camera has advantages and disadvantages. These cameras are very specific to appropriate shooting conditions (Rodney, 1997a). Cameras in this class are all expensive, ranging from $7,000 to more than $40,000. The resolution of these cameras ranges from 1.5 million to 150 million pixels. At this resolution, the file size of one picture can be 144 MB.

Image editing

Digitized images may require editing. These adjustments include modifying the size of the image, adjusting the resolution to be suitable for a printer, and adjusting color. Additional enhancements can be made to sharpen the image, adjust the contrast and brightness, or remove shadows or unwanted backgrounds. In general, white backgrounds are the most economical since no ink is used, thus reducing printing costs. If the original background is black or distinctly contrasts with the object, it is very easy to remove the dark background, leaving white. It is more tedious, but possible, to remove backgrounds that are not distinct from the object. A procedure called masking makes removing the background easier. Shadows can be added to give depth to the image.

When modifying the image size it is important to keep the image resolution compatible with the resolution of the printer. The printer cannot print partial dots. Each image pixel must correspond to a whole number of printer dots. If the image does not correspond, moiré patterns will appear in the printed image. The resolution of the image must be set so that it divides evenly into the printer resolution. Follow the recommendations for the printer.

Digital images from photo CDs, digital cameras, and video capture produce images at 72 dpi. The size of the image increases as the resolution increases. We have had good results with placing these images in desktop-publishing software at 72 dpi. The image is resized, constraining the ratio of length and height. The program is told the resolution of the printer and, in conjunction with the printer driver and color-correction software, the program automatically adjusts the image. This method is working especially well with a digital camera.

There are software packages developed specifically for image editing. It is highly recommended that one of these packages be purchased. A computer used for image editing will require much RAM and disk space. A minimum of 16 MB RAM is recommended, but it is preferable to have at least 32 MB. Some of the original high-resolution scans alone will be 12 MB. If there is not sufficient memory available, it will not be possible even to reduce the image down to a workable size. Disk drives should have a minimum capacity of 2 GB.

Layout development

Composing the documents can be done using an advanced word-processing, drawing, or a desktop-publishing program. The program must work with at least 256 colors; however, a program capable of handling images with thousands or millions of colors is highly recommended. The view on the computer monitor does not affect the image sent to the printer, but a monitor displaying a high number of colors makes it easier to visualize how the publication actually will appear when printed. Currently, many of the flyers or single-sheet publications produced at the Univ. of Guam were prepared using drawing, word-processing, or desktop-publishing software.

Frequently, a combination of pictures helps convey information more completely. For example, combining an image of the entire object with closeups of specific parts of the picture or with line drawings is a recommended approach for illustrations. In general, it is best for closeups to be digitized as separate images. When working with film scans or photo CDs, the image can be magnified on the computer screen, and the enlarged image can be cropped to show only the desired portion. For example, to illustrate unacceptable market quality, there can be a picture of poor-quality cucumbers with various defects and closeups of specific damage. The overview can have an outline of the area with a box to show what is enlarged. Another example of using a combination of pictures would be to have a picture of a tree or shrub and closeups of the flowers, leaves, etc. A high-contrast silhouette also can be included to show the growth habit.

It is also possible to draw colored arrows to illustrate gray-tone images. Color lines are much more visible than black, white, or gray lines. Use care in using color for labeling the illustrations, since individuals who are color blind may not be able to distinguish the lines from the picture. Orange has been found to work well.

In planning the layout of color images, one must decide whether the publication will be single- or double-sided. If it is double-sided, the decision must be made whether color will be printed on only one side or both sides. Printing color on only one side allows the noncolor side to be photocopied, reducing the printing cost. Since ink-jet printer ink is water soluble, one approach to protecting the color images is to make a folded single-sheet flyer that is four pages long. The color can be printed on the inside pages, and the outside pages can be copied.

Disseminating POD materials

Printing. Printing can be handled by any type of printer, from dot matrix to dye sublimation to high-end commercial. These vary greatly in the characteristics of the output. One aspect is the resolution of the printer, and the other aspect is whether the output is black and white or color. In many cases, black and white pictures will suffice to illustrate something; however, color frequently enhances an illustration. In other cases, color is essential. There are five color technologies used for color printers: thermal-wax transfer, dye sublimation, ink jet, phase-change solid ink, and laser (Fraser, 1994). The prices range from $300 to $14,000. The choice of printer depends mainly on budget and intended use. Dye-sublimation printers generally cost more. If the handouts will be used in situations in which transparencies of the handouts will be used, it is important to consider the quality of the transparencies in addition to the paper printouts. Thermal-wax printers produce the best transparencies. The per-page printing costs also vary. Dye-sublimation printers produce photographic-quality pictures, but the cost is $3.00 to $4.50/page. Although not intended for bulk printings, ink-jet printers are the cheapest and produce high-quality transparencies. Ink-jet printers, however, use a water-soluble ink, which limits their usefulness for producing durable printouts. Phase-change solid-ink printers use plain paper and produce good-quality output with durable inks. Color laser printers are best for bulk printing since they have a low cost per page.

The estimated printing cost ranges from $0.13 to $4.50/page for various printers (Stone, 1993). The cost depends on the percentage coverage of the page. For example, for one brand of printer at 25% ink coverage, the cost is $0.13/page, while printing with 100% coverage is $0.50/page (Stone, 1993). The cost of the printer and the efficiency of using ink also must be considered. Some printers may have a higher initial cost but have a lower annual cost if they use less ink per printing (Goodwin and Weibel, 1994).

In addition to the basic printer, our experience indicates that the RAM in the printer must be increased to allow the printing of complete layouts. Adding RAM generally speeds printing. A high-speed connection between the computer and printer is advantageous.

Printouts from a POD system can be used for many purposes. By deciding on certain layouts, templates can be made, which reduces the time of production per flyer. The headings and credits can be included as part of the layout. The format of layouts has evolved as we have become experienced in printing the POD publications. The original publications used only one side of single sheets of paper, which was the easiest to print. New publications are two-sided, and some contain multiple pages. For workshops and instructional materials, copies of the documents can be printed to transparencies or slides so that the participants can follow on a hard copy what is presented on a projected screen. With the currently available flat-screen monitors, high-quality slides can be produced by photographing directly from the monitor.

Electronic dissemination. Portable document format (PDF) publications makes it possible to produce publications at one location and disseminate the completed document electronically through Internet via a WWW server. This allows an extension specialist, for example, to produce publications and disseminate them electronically to field agents. Publications can be saved in formats that allow various platforms of computers to open, view, and print files. It is possible to use password protection to limit the users to printing or on-line viewing.

Documents also can be disseminated, allowing customization of the document for specific uses. For example, the text portions could be translated into another language or the document could be modified to function as an extension publication or as classroom instructional material, where the version for the classroom might be expanded to include additional information. The reverse is also possible—the document could be reduced to a picture and some taxonomic information so that it can be used as a flash card for practicing plant identification.

Conclusions

Printing on demand is valuable for the timely development of printed materials. It allows for refinements and modifications without a large investment of time and money for reprinting publications. Once a document is used as a POD publication, demand may indicate the need for a bulk printing.

As computer technologies change, there will be continuing improvements in the resolution of the digital sources of pictures and in printers. The prices of the components, particularly the printers, also will decrease, making POD publications feasible for more individuals.

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